THE

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The ELECTRICAL REVIEW List of Electric Light Central Stations of the United Kingdom	*Special Supplement*

THE

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THE GROWTH OF CENTRAL STATIONS.

IT is fortunate that the average central station engineer looks kindly upon statistics, or lists and details of electric lightin works would be more imperfect than they are. During the collection of the information given in another place, we have been gratified at the ready assistance rendered by works' managers. Four or five have failed to send returns, but we do not look upon such omission as indicating resentment; they rather suggest that important extensions are in hand. But experience has taught us never to despair of returns; indeed, some of the missing ones may come to hand six months hence—the delay, no doubt, being due to the Postal authorities. Still, in spite of one or two omissions, the work of collecting electrical statistics is easy when compared with the trouble our friends the gas people have in gathering information from the gas engineers. In the preface to a well known gas directory, the editor gives instances of the gracelessness of gas men. One said "Your form went to the dogs, and they tore it up;" another said "the statement fairly represents the truth;" one return said "no *alteraion* to *menishon*;" while one manager added to his corrections "Miserable little hole not worth putting in directory." Who can conceive of an electrical man saying that? It is also worth recording that even gas with its long start is not always readily taken up for public lighting, for the manager of a gas company said "purely an agricultural district, and the inhabitants refused to sanction the use of the public lamps."

The year 1895 has not been remarkable for the number of new central stations that have commenced work. Not more than 14 or 15 were opened, which is considerably less than those started in 1894 or 1893, but then it has to be remembered that the most important towns of the kingdom are now supplied with electricity works, and we may expect the smaller towns to be slow in taking upon themselves the responsibilities of electricity works. It is interesting to observe, however, that in England alone there are 66 towns, with a population of over 30,000, that are unprovided with electricity works. It is true that in some of these, works are either in course of construction or have been decided upon; but the number does not exceed 12, which leaves 54 fairly large towns that have not yet had the courage to embark upon public electric lighting works. Coming to still smaller towns, there are 106 with a population of over 20,000, and 212 whose inhabitants number more than 10,000, in which electric lighting is practically unknown. The smallest town in England as regards population in which municipal works exist is Whitehaven, which has something over 18,000 inhabitants, while the smallest municipal borough in which a company operates is Thetford, where the population does not exceed 4,500. A contemplation of the foregoing figures should inspire the electrical contractors with hope, but before one can look for much extension amongst these towns, the advan-

tages of electric lighting need to be brought prominently before them.

The advantages of municipal ownership of electric lighting works are clearly recognised by the majority of local authorities; hence it is not surprising to find that the majority of electric lighting works opened during 1895 are owned and controlled by municipalities. There were not more than three stations opened by companies last year, against 10 owned by local authorities. The largest company works opened during 1895, those of the Dover Electricity Company, have a capacity of 330 kilowatts, while the largest Corporation works, those of Edinburgh, have a capacity of 1,200 kilowatts. Coventry, the smallest municipal works opened during 1895, has a capacity of 150 kilowatts, against the 50-kilowatt capacity of Oswestry, the smallest company works.

The most satisfactory feature, however, is not the increase in new central stations, but the extensions that have been effected at many of the established works. Manchester, Blackpool, Southport, Portsmouth, St. Pancras, and others too numerous to mention, have made considerable additions to their plant, and no doubt the chief work of 1896 will lie in the direction of extensions.

There is more uniformity in the charges made to consumers than one might expect, considering that many works have not yet turned the corner. Even where 6d. per unit is exceeded, there is generally a sliding scale in vogue, or more often than not, Wright's method of charging is in use. In many other respects there is considerable variation in the conditions under which the stations work. There is no safer indication of the character of a district than the income derived per lamp. It seems to be something now-a-days in electric lighting to hold a record, no matter whether it is bad or not so long as it is one. That being so, there would be no difficulty in awarding the prize for the lowest revenue per 8 C.P. lamp to the Kelvinside Electricity Company, which obtain the unique sum of 2s. 9d. per lamp. There are, of course, special circumstances which explain this, but the company cannot be, at any rate, accused of want of confidence in the undertaking, when in the face of that they charge only 6d. per unit. In spite of such instances as these, we may look upon the growth of central stations as a healthy one, and though there are many works which earn no dividends for the shareholders, and many municipal stations that do otherwise than relieve the rates, we are sanguine that the majority of them will, before long, do credit to the wisdom of their sponsors.

SOME POSSIBILITIES OF ELECTRICITY IN DENTAL SURGERY.

Until recently electricity has been but little employed in dental surgery, except for the driving of mechanisms, cauterisation, the translumination of soft tissues, or the illumination of cavities, and although many dentists in this country consider that it is unlikely to be used to any great extent, American dentists, who have always led the way in the development of this science, are demonstrating that, so far from the applications of electricity having reached their utmost limit, the field is getting wider and wider.

One of the great drawbacks to the more complete adoption of electricity in general dental practice, is cheap outfit or installation. Any man who can put up a bell now calls himself an "electrician," and this is frequently the kind of person employed when dentists, half-hearted as they are too prone to be, begin to add electrical appliances to their surgeries. Dental electric outfits should only be purchased from good firms, who can send competent men to instal them.

At the recent annual gathering of the Central Dental Association at Newark, N.J. (U.S.A.), Mr. G. H. Guy made an interesting speech on the electrical possibilities of the future in dentistry. He pointed out that occasions constantly arise in dental practice when anæsthetics and other drugs may be introduced into tissue and into dentine, and that their familiar topical effects may be vastly enhanced by the aid of electricity. Broadly speaking, he said any drug that has been used previously without electricity within the mouth to produce a specific effect, may now be used with tenfold its former power for good.

This method of applying drugs is beginning to be known amongst dentists as *cataphoresis*. Obviously the operation of the resistance of the substance used has a most important bearing in the therapeutical applications of cataphoresis. If the resistance is too high, as with chloroform for example, or if too low as with acid and saline solutions, disappointing results are obtained. Guiacol, however, itself a non-conductor of electricity, by the addition of a very minute quantity of some innocent substance possessing electrolytic properties, such for example as the salts of the alkaloids, caffeine, quinine, &c., may be caused to penetrate tissue by the aid of electricity, and thus exhibit anæsthetic effects unattainable by the aid of the added electrolyte.

Mr. Guy is of opinion that the sinusoidal current will sooner or later find its way into dental surgery. The two elements, the frequency and the graphic curve, or as D'Arsonval calls it, "the characteristic of excitation," determine whether the current is painful or not, and it is pain only which limits the extent to which the induced currents from ordinary medical apparatus may be administered. Under this head, too, it may be observed that the time is fast approaching when guesswork in electrical dosage will be a thing of the past, and when electricity will be prescribed and administered not only in measured units of intensity, density, and time, but with definite idea of the E.M.F. curve and of the therapeutic indications that a given curve may be expected to fulfil.

As regards the translumination of soft tissues, it is probable that more attention will be paid to the intensifying of the light, and that as much as 20 candle-power may be used. The heat difficulty has been surmounted already by enclosing the exhausted bulb within another, through which water is made to circulate; and even this may not be necessary if the "Tesla glow" should be made to lend itself to the operation of translumination.

Amongst Mr. Guy's hopes for the future is the sterilisation of cavities in the teeth, jaw, &c., by means of the "Tesla glow." If this should ever become possible, pyorrhœa alveolaris, and other such bug-bears to the dentist will have no further terrors, and a new charm will be given to dental work when light shall be available, which will

illumine, purify, and sterilise, killing the deadliest germs that work havoc in the human mouth.

Of course, Mr. Guy could not avoid referring to the Röntgen rays—no paper to-day is complete without something about them. He observed that where fangs, and other parts of the teeth, are being treated, it is often necessary to know which teeth already contain filling, and there are other difficulties which at present are more or less the subject of guess-work in dental practice. Now, as metallic substances intercept light to a greater extent than bone does, a cathodograph will show the location of all the filling in the teeth that have been operated upon. Dr. Morton has proposed to put the rays within the mouth, and a sensitive plate within the plate-holder outside the cheek, and to determine thus the existence of ostitis, deformations, diseases of the bone, pus deposits—in fact, the whole concealed pathology of the teeth in their relation to the jaw and gums would thus be revealed. Dr. Morton, like nearly all others who have animadverted on the X rays, cannot be charged with not being sanguine. However, if all the glory of these rays be possible in other directions, there is no reason why dental surgery should not come in for a share of it.

Artistic Engine Rooms.

For some time past there has been visible a tendency in America, says Mr. E. T. Adams in the *Engineering Magazine*, towards better engine rooms, and he illustrates some half-dozen at various theatres, stores and power plants, which are finished off and decorated in a highly elaborate manner. The picture of the engine room at Keith's theatre, Boston, besides the inevitable palms, which always accompany artistic interiors, contains a couple of non-sit-uponable æsthetic chairs. American decorative work has often a strong flavour of the barbaric. Mirrors all over, which reflect at all angles, are, we hope, becoming less common, but not long since every pretentious railroad car was full of them. We certainly cannot find fault with the spirit which leads to this decorative work, but much of it is garish and out of tune, as the two flimsy chairs are out of harmony with an engine room. Of late years, in England, since the introduction of the horizontal type of engine, the care of engine rooms has fallen below what it was in the days of the beam engine. Architectural in proportions they revolved slowly and comfortably, and did not throw oil, and many of the Lancashire mills had engine houses of considerable merit, with tiled floors and general neat finish. With the very elaborate interiors described by Mr. Adams, the enclosed type of engine is almost a necessity to prevent oil throwing. Unfortunately, with all the elaboration we miss a prominent feature of English engine rooms, namely the overhead traveller. In none of the illustrations is there a suspicion of any form of lifting tackle. An overhead traveller is, perhaps, not a thing of beauty though it is a joy to the engineer for ever, but it may be made to present a neat appearance, and we can hardly prefer any amount of art decoration to an overhead traveller. True design would have included the latter and subordinated the plan of ornamentation to it. True the engines are not of very large size in any one of these artistic interiors, and this may be the designer's plea for omitting the traveller. But the principle is bad, and no amount of art can cover the lack of such essentials. If this sort of thing be allowed, we shall expect an engine builder to parry enquiries about a cracked cylinder or a missing cross-head, by drawing attention to the ceiling panelling. This is the danger of allowing too great a license to the mere painter and decorator.

The *Engineer* Road Carriage Competition.

Our contemporary now publishes a statement as to the arrangements in connection with their road carriage competition. In the first place the grounds of the Crystal Palace have been selected in which to hold the competitions, and the Judges are Messrs. Aspinall, of the L.Y. Railway, Dr. John Hopkinson, and Sir F. Bramwell. The competition is to be international. There are to be four prizes, viz.:—

A. For the best mechanically propelled vehicle, to carry four or more persons, including driver, not to weigh when loaded over two tons. The prize is 350 guineas.

B. For a vehicle of not over one ton to carry one, two, or three persons. Prize, 250 guineas.

C. For a vehicle to carry, besides the driver, not over a ton of goods, and to weigh, when loaded, not over two tons. Prize, 250 guineas.

D. For a vehicle not weighing over one ton, including the driver, and 5 cwt. of goods. Prize, 150 guineas.

E. A supplemental prize of 100 guineas for a vehicle either for goods or passengers, propelled by oil or spirit of sp. gr. below 0·8, and a flashing point below 73° F., Abels test, and constructed to satisfy any Act of Parliament, and the rules to be made thereunder for the time being in force. Except in the case of E, no oil or spirit is to be below 0·8 sp. gr., or 73° flash point.

Vehicles must be entered before the last of July, particulars as to entry being obtained from the office of our contemporary, 33, Norfolk Street, W.C., and vehicles must be delivered at the Palace before October 2nd. There is to be a practical run of 100 miles out and home, or a total of 200 miles. There are numerous conditions given, and there are also stated the points which will be considered by the judges in making their award; but the practical working run, while it must not average less than five miles per hour and anything over 10 miles will not be credited, may be done entirely on the go-as-you-please system. Intending competitors should at once secure a copy of the conditions.

Fires due to Steam Pipes.

The burning of a cotton mill in America having been thought due to the carbonising of the lagging of a quadruple engine has again brought this interesting question to the front, and Mr. Edward Atkinson, of Boston, states that he has made an experiment that convinces him that the heat of steam is quite sufficient to put carbon into a flame, under certain conditions. In testing certain heat-retarding substances he prepared some slabs of wood pulp 1½ inches thick, and very porous, such as are used on refrigerators. He used this material to cover a small oven heated by a lamp, the inner oven was 1 inch distant from the outer case, and he heated it to 400°. It contained a piece of the wood pulp isolated from metallic contact with the oven, and this was left one hour exposed to a temperature of 400°, at the end of that time it was of a dense black colour instead of pure white, as at the commencement, having been converted into a very porous charcoal. He then opened the door and exposed the slab to a copious current of fresh air, and in less than a minute it took fire and burned to ashes, and he repeated the experiment with the same result. While 400° corresponds with steam of 238 lbs. pressure, it is stated that the carbonising of wood is equally effected by steam of only 212°, but we scarcely look on Mr. Atkinson's experiment as fully conclusive. The same result secured by an actually steam-heated oven would be a more convincing test. At the same time, it can scarcely be doubted but that finely cellular carbon will oxidise sufficiently rapidly to spontaneously ignite just as will finely divided lead or iron when dropped through the air.

DYNAMOS FOR TELEGRAPH WORKING.

By W. SLINGO and A. BROOKER.

A large and important telegraph station is of necessity situated in the heart of a town or city where space is valuable; and, consequently, any reasonable suggestion for economising space in such a station merits careful consideration. The source of electrical power, whatever it may be, demands, for a large station, a heavy expenditure on plant, rent, and maintenance, and therefore affords a promising field for any administrator bent on economy. Except in a comparatively few instances, primary batteries are still employed for working telegraph lines, and, generally, every line or circuit has its separate battery. So far as freedom from breakdown or interruption due to a failure of the source of power is concerned, this is, without doubt, the ideal system. The space occupied and the amount of wiring involved, are, however, considerable, as may be gathered from the fact that on a single line worked on the Delany multiplex system, no less than ten separate batteries at each end of the line would be required, having an electromotive force ranging from about 8 to, in some cases, 240 volts. These high pressures are never allowed to get on to the line, for, taking into account the resistance, apparent and real, of the apparatus, &c., the maximum potential difference between the nearest insulator and earth is in no case allowed to exceed 120 volts.

It will be evident, however, that when primary batteries are employed, the number of cells required for a large station amounts to many thousands, and the prime cost, cost of maintenance, and space occupied are very great, because the batteries must be arranged so that every cell shall be easily accessible for inspection and renewal, and a considerable number of spare batteries must always be kept ready for emergencies and to replace defective ones, while the latter are being examined and brought into good order.

It may be remarked that any source of power is equally effective from a telegraphic point of view, provided only that the requisite potential difference can be maintained at the required point at the sending end of the line. Thus, given two batteries of different types of cell, but of equal internal resistance, electromotive force, and constancy, there is absolutely no difference in the speed or efficiency with which a line can be worked from these batteries, although the contrary opinion frequently obtains. There is one practical objection to the use of a battery of very low internal resistance, viz., that a heavy current results when the battery is short-circuited, accidentally or otherwise, and the apparatus and battery are then liable to injury. Further, some classes of reversing apparatus have to be so adjusted that the battery is momentarily short-circuited every time the current is reversed, and consequently the battery resistance must in such cases be sufficient to avoid the risk of a too heavy current passing through the apparatus; it should certainly be not less than 2 ohms per volt. In the event of a very low resistance cell being employed, the resistance may be brought up to this amount by the insertion of an artificial resistance.

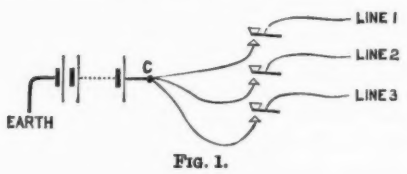


Fig. 1.

The best way of reducing the space occupied by the batteries is to employ a "universal" system of working, that is to say, to supply a large number of circuits from one battery. The problem is a very simple one when the lines offer approximately the same resistance and are worked by single current, as it is only necessary to permanently earth one pole of the battery, and from the other pole run a lead to the key or sending apparatus of each circuit (*see* fig. 1). It is necessary to ensure that any one line shall get approximately the same current, no matter whether all or none of the other lines are working, that is to say, the point, C, from which the battery leads radiate must, under all circumstances, be maintained at the same potential. The problem is precisely similar to that met with in the practice of running a varying number of incandescent lamps in parallel without any perceptible variation in the luminosity of any one lamp, and it will be seen that it is only necessary to make the resistance between the point C and the earth, through the battery, *very* low; the arrangement would be perfect, that is to say, there would be no variation if this part of the circuit could be made so as to offer no resistance at all.

It is an expensive matter to construct and maintain primary batteries of such dimensions that a number of cells in series shall offer a resistance less than, say, one ohm, and it is evident that a battery of secondary cells is exactly the thing for such work. There is practically no limit to the number of lines which can thus be worked from a suitable secondary battery, as the current taken by each line rarely

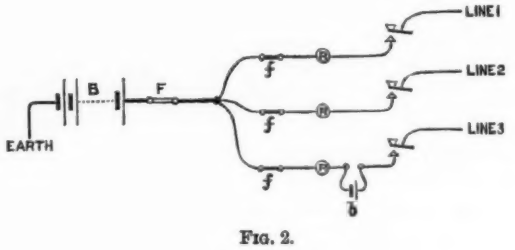


Fig. 2.

exceeds 70 milliamperes, and is usually less than 40 milliamperes; and, although a good secondary battery is expensive, it becomes cheaper than primary batteries if a sufficient number of lines are worked from it. It is obviously useless to employ a battery of very low resistance unless the resistance of the connection to earth and to the point, C, be also very low, as any resistance between the point, C, and earth acts as if it were in the battery itself; such connections should, therefore, if long, be made by means of a thick copper strip or cable.

It should be clearly understood that when the resistance between the point, C, and the earth is sufficiently low, the resistance of the various lines may differ enormously, and yet no variation of current strength will be observed on any one line when the others are working. The current obtained on any one line, however, being inversely proportional to its resistance, the short low resistance lines may get a far stronger current than they need, but this may be compensated for by the insertion of appropriate resistance coils in the various leads between the point, C, and the keys. The electromotive force required for each line may, however, also be adjusted by tapping the battery at different points for the different lines; and this method, besides being less wasteful, has the advantage that an increase in electromotive force may, when necessary, be readily obtained to compensate for an extension of the line, or for a heavy fall in its insulation. It is only necessary in such a case to tap the battery a little higher up, or further away from earth. Of course, the same result could also be obtained by the employment of an adjustable resistance, although such a method has its objections.

The chief disadvantage of universal battery working is that a failure of the battery means that a large number of circuits are suddenly deprived of power, and the inconvenience is greatest when the system is worked under the most favourable conditions, viz., with a very large number of lines served by one battery. With constant attention and inspection, the secondary battery itself may always be guaranteed to remain in good order; but it is impossible to avoid short-circuiting by accidental earths on the line, or at the instrument. The risk of failure may be reduced to a minimum by inserting a fuse in every lead between the battery and the instrument, when only the particular circuit on which the fault occurs will be deprived of current; and by placing a resistance coil in each lead it becomes impossible to short-circuit the battery even by a dead earth at the instrument. These fuses, to have the maximum protective effect, should be placed as near to the point, C, as possible, and the resistance coils, having a given minimum value to protect the battery, may be increased to equalise the current sent out on the different lines as explained above.

A main fuse should also be placed in the main lead from the battery, and various other devices, such as the grouping of a small number of circuits on to a branch fuse, readily suggest themselves, many such devices having long been employed on electric lighting circuits.

Fig. 2 shows the positions of the main fuse, F, the smaller fuses, *f*, and the resistance coils, R, and in the case of line No. 3, a small battery, *b*, is inserted, showing yet another method of increasing on emergency the power on any one line when necessary. The type of cell and the internal resistance of such a subsidiary battery is quite immaterial, but it is necessary that it should be fairly well insulated from the earth.

When the lines are worked on the "double current" system, that is to say when the apparatus at the distant end of the line is actuated by a *reversal* of the current, some slight modifications are necessary. Under ordinary circumstances with one battery set apart to each circuit, a reversing key or equivalent piece of apparatus is employed to connect first one pole and then the other to line, the opposite pole of the battery being at the same time joined to earth. With such reversing keys it is not possible to work more than one circuit from the same battery. Were two such keys joined up, the battery would be short-circuited when one key joined the positive pole and the other key the negative pole to earth.

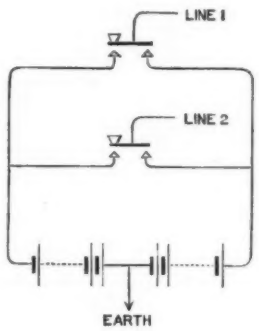


Fig. 3.

In order to work double or reversing-current circuits on the universal battery system, it is necessary to have two separate batteries, preferably of equal electromotive force, the positive pole of one and the negative pole of the other being permanently connected to earth. The reversing key must be replaced by a key or apparatus which is, in effect, a simple lever connected to line and playing between two contact points, one connected to the positive and the other to the negative pole, so that currents alternating in direction can be sent along the line (see fig. 3). Precisely the same precautions need to be taken as in the case of single current working, to avoid the short-circuiting of the battery, and it will be noticed that in the case of double current working not only must an earth at the apparatus be avoided, but there is a chance of short-circuiting both batteries in series. This latter accident is liable to happen when the play of the lever is being adjusted carelessly, and the lever is allowed to make contact with both contact studs simultaneously.

Although, as we have pointed out, secondary batteries can, under favourable conditions, be used economically to replace primary batteries, they are expensive, require a good deal of attention, and are comparatively inefficient, that is to say, a large proportion of the energy spent in charging them is wasted. It is evident that there is much to be said in favour of obtaining the necessary power direct from dynamos, if a sufficiently reliable and flexible arrangement can be adopted. It need hardly be pointed out that the use of dynamos could only prove economical in stations where a very large number of lines could be served, but it is, of course, only in such stations that the need for a substitute for primary batteries is urgently felt.

It is a noteworthy fact that in the Chicago office of the Western Union Telegraph Company, an installation of dynamos has recently been put in to replace no less than 60,000 primary cells. This fact certainly shows that the officers responsible have considerable confidence in the capabilities of the dynamo for telegraph work, and, judging from the particulars published in the Chicago *Electrical Journal*, we should say that the installation has every chance of success.

The machines are driven by three 20-H.P. steam engines, three electric motors which can be connected up to the lighting mains being also installed as a reserve in case of failure of steam power. Two 45-volt dynamos supply current to all the local or short city lines, two 7-volt machines supply the ordinary sounder local circuits, and two 23-volt machines the local circuits on "multiplex" sets, the normal output being 11, 22, and 44 amperes respectively. The most interesting part of the installation, however, is the arrangement of 15 machines to supply current to the longer and more important lines. These machines are joined in three sets of five each with their armatures in series, one set being always kept in reserve. The two working sets are used to supply positive and negative currents respectively, the negative terminal of one set, and the positive terminal of the other being permanently earthed. These machines develop a potential difference (starting from the earthed end of the set) of 75, 75, 70, 70 and 60 volts respectively, and, consequently, the series may be tapped, either for single or double current working at five points, the potential of these points being 75, 150, 220, 290 and 350 volts.

Fig. 4 will serve to make this arrangement clearly understood. The various points of different potential are shown connected to the positive or negative studs of double current keys or pole changers, and, of course, any number of connections may be so made, or either set of machines may be tapped at any point for single current working. It will be observed that at the apparatus used on the longest lines a potential difference of 700 volts can be obtained. Such high pressures are not employed in England for telegraph work, but we presume that in the Chicago installation each circuit is well protected by fuses and resistance coils, in which case little inconvenience need be experienced, as the reversing keys or pole changers used in the States are actuated by a local circuit and need not be touched by the operator except for the purpose of adjustment, in which case, we imagine, the battery leads would be temporarily switched off.

In order to facilitate the regulation of the pressure only one machine in each set is self-exciting, and this machine supplies current to the other machines in the same set, all the field-magnet coils being arranged in parallel and provided with adjustable resistance coils.

Generally, the installation appears to have been carefully thought out, and if it does not attain success, it certainly deserves it.

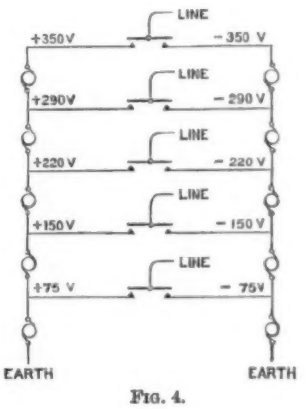


Fig. 4.

One objection to such an installation is the necessity for continually running the whole plant even during those hours when the work is very light; and with such a large number of machines not only is the efficiency exceedingly low, but the risk of failure at some point or other must at all times be considerable. We are of opinion that a much more reliable and flexible system could be obtained by means of motor-generators run from lighting or power mains, which are always available at a large telegraph station, as the risk of failure of supply from such mains is, or should be, exceedingly remote. Such a system would be more efficient, and far cheaper to instal and maintain than either secondary batteries or dynamos used direct, the space occupied would

be far less, and motor-generators could be used in much smaller stations than those in which it would pay to instal dynamos and engines. A motor-generator when intelligently used requires exceedingly little attention, is more reliable than any engine and dynamo combination, and changes can be effected as easily as with a set of batteries. We look forward with some interest to a trial of these machines for telegraph work.

TELEPHONY AND TELEGRAPHY.

(*Concluded from page* 526.)

(*i*) Telephonic conversation is carried on between the offices S_1 and S_2 by means of the Cailho arrangement (fig. 10).

It will be observed that in these last two installations three Cailho bobbins are arranged on the circuit, one being at the point of bifurcation.

In discussing these various arrangements, we have only treated the question technically. We ought, perhaps, to make certain reservations from a practical point of view, as we should place a somewhat delicate instrument, such as the phonic calls, in the hands of operators with very little experience in the manipulation, and above all the regulation of such instruments.

From all the foregoing explanations we may conclude that it would be easy in certain cases to connect telegraphically with a principal office, E, three secondary offices arranged on the same conductor.

Let the Government office, E, and the three secondary offices, S_1, S_2 and S_3 be connected as shown in fig. 11.

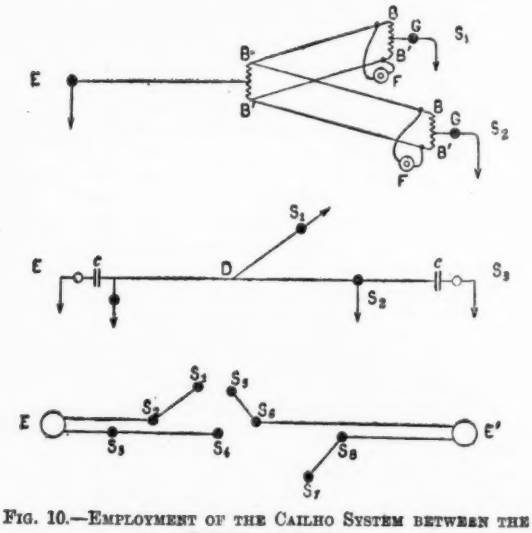


FIG. 10.—EMPLOYMENT OF THE CAILHO SYSTEM BETWEEN THE STATIONS, S_1 AND S_2.

FIG. 11.—DIAGRAM OF THE COMMUNICATIONS BETWEEN ALL THE SECONDARY OFFICES AND A HEAD OFFICE, E.

FIG. 12.—DIAGRAM OF AN ARRANGEMENT CONTAINING A PROBLEM TO BE SOLVED.

The transmissions between the secondary offices and the head office could only be in succession, *i.e.*, each of the offices, S_1, S_2, S_3; the office S_2, for instance, could only communicate with E when the other offices, S_1 and S_3 were not transmitting. The arrangement to be adopted would be the following :—

The offices, E, S_1, and S_2 would be provided with the telegraph and signalling apparatus now in use; E and S_2 would possess phonic calls, and would correspond, by means of alternating currents sent out by an induction coil, in the primary of which a vibrator would work. A telephone would act as receiver at each station. One condenser would be introduced into the circuit at the entrance of the office, S_3 and a second between the line and the special office of the station, E, which is charged to correspond with the similar telegraph office installed at S_3.

The offices, S_1 and S_2, should be provided with the arrangement represented by fig. 3, comprising a telephone and a key, K, enabling each of them to ascertain whether E and S_3 are in correspondence, before calling to the station, E, with a view to transmitting a telegraphic despatch.

It is important to note that the arrangement just described would only allow of the saving effected by laying a wire, E, D, between E and the bifurcation of S_1. In short, by grouping S_3 and S_2 on the longer wire, it would be sufficient to connect S_1 to the office, E, which would be alone on its wire. With this last combination we should not have to use plant different from that now in service. Moreover, the wire, E, S_1, might be utilised if occasion required for the service of another office.

We have now shown, with their advantages and disadvantages, the arrangements that would enable telegraphy and telephony to be carried on along the same wires, either alternately or simultaneously.

Lastly, we will conclude by setting a problem for those electricians that are interested in problems of this nature.

Fig. 12 represents two head offices, E and E′, which we will suppose to be situated at a distance of 50 kilometres from one another. Eight villages, numbered 1 to 8 on the figure are connected, two by two, with the State offices, E and E′.

1. Would it be possible to utilise the whole, or part, of these conductors, with a view to establishing telephonic communication between E and E′ without interfering with the grouping of the secondary offices ?

2. If so, what would be the most economical arrangement to adopt ?

We will publish the solutions sent in after the combination which we shall deem most suited to the requirements of the case.

ON THE ALTERNATE CURRENT ARC.

STUDENTS of arc lighting are familiar with the painstaking researches which have been carried on during the past few years in the works of leading electrical firms both at home and abroad. It is something to be proud of that whilst advancing commercially, these firms have not been reluctant to spend time and means in prosecuting much that is "only pure research, though even this (by some) much despised *pure research* has its commercial aspects, as those who have been enterprising enough to carry them through have found to their no small profit. Amongst the latest of these are certain investigations chiefly carried out in Germany, the results of which were recently the subject of a descriptive paper by H. Gorges at a meeting of the Electrotechnical Society of Berlin.

Gorges points out that with the continuous current the positive carbon develops more heat than the negative. In the case of alternating currents, the carbons are alternately positive and negative, and the luminous intensity is constantly oscillating from one to the other. Now, the eye is less sensitive to light variations than to changes in the heat of the arc through variations of current flow. Above a certain frequency the eye can no longer perceive the oscillations, although the light may vary materially. The limit of perception is probably located at about 60 periods per second. When the arc is enclosed in a ground glass globe it appears more steady than when the envelope is clear; while aided by a reflector, which, placed above the upper carbon, throws back in a downward direction the rays from the lower carbon blending—breaking the joints, as it were, the eye is unable to detect any wavering at 50 periods per second. The optic nerve requires a certain period of time to receive an impression, and a definite period for releasing it. If the second impression is made before the first is lost, then the impression appears continuous. The experiment of a glowing stick tied to a string, and whirled rapidly round, is an instance to the point, or better still, a wheel fitted with lamps and set in rapid rotation.

The length of the arc has a decided influence upon the amount of light shed with an equal expenditure of energy. The extremities of the carbons are truncated cones, and be-

tween the summits of these cones is the arc. This should not be too short, because of the reflecting surfaces. Yet, on the other hand, the heat is necessarily higher inversely as the length of the arc. In fig. 1 is shown how the light produced per watt diminishes with the lengthening of the arc. The numbers in the figure give the length of the arc in millimetres. When the arc is abnormally long, the light is of a decidedly violet colour, the horizontal luminous intensity being quite feeble.

The nature of the arc is dependent largely on the form of the ampere curve. With certain machines, by the aid of a simple commutation, the curve of the current may be modified. In the experiments mentioned below, the machine used was tri-phase, and arranged either for the star or the triangle system of circuits. Taking only a single branch, a flattened curve resulted. See fig. 2, I.

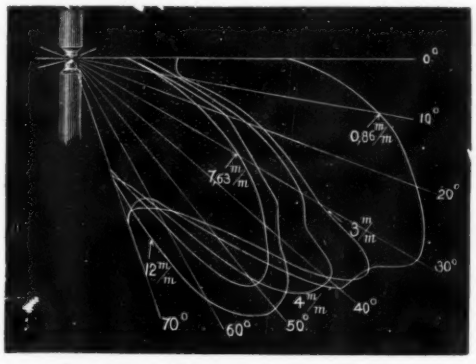


Fig. 1.—Variation of Luminous Intensity per Watt, with Length of Arc.

Connected in the star form by superposing the currents from two branches, a curve was formed closely approaching the sinusoidal (fig. 2) dotted line. Coupling the two branches in opposition, the curve produced was that shown in fig. 2, II.

The noise of the arc depends largely on the curve form. The heating and periodic dilatation of the carbons, and of the atmosphere, produces diverse sounds. With the simple sinusoidal curve the sound is light, and the tone pure. Curves of brusque variations give the higher harmonics more or less intense. The sonorous vibration increases with

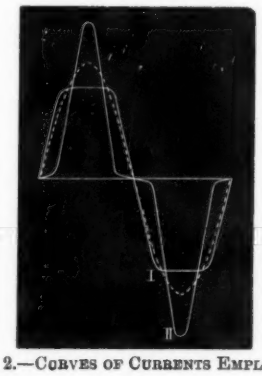
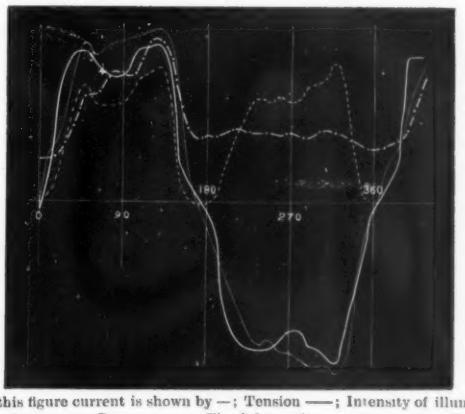


Fig. 2.—Curves of Currents Employed.

the intensity of the current, the frequency and the length of the arc. Glass globes deaden the sounds materially. On the other hand, with pointed curves, the sounds sometimes become very disagreeable. Finally, the nature of the carbons has much influence on the character of the tones.

With regard to the voltage of the arc, this depends upon the form of the current. A constant current arc, instantaneously interrupted, re-illumines at once, because the air is of so high a temperature as to remain sufficiently conductive during the short extinction. With an alternate current the voltage should maintain a certain amplitude, because it is re-formed after each interruption. It seems to be established that this value should increase with an enfeebling of the current, and that in consequence the period of cooling should increase. The mean tension, on the contrary, is less with sharp curves than with flat ones. It has been found, for example, that to produce an arc of 2 mm. with a sharp curve, 23·5 volts are necessary, and with a flat curve, 30·5 volts. The voltage then depends upon the form of the current, which does not affect the regulation of the lamp, except so far as this is varied by the charged action of the electromagnet with the varying forms of current.

The temperature of the carbons, and hence the luminous power, is determined by the electric energy expended in the arc. With high frequencies the quantity of light is probably independent of the form of the current curve. But with the frequencies of common practice the luminous power increases with the flattening of the curve.



In this figure current is shown by —; Tension ——; Intensity of illumination —. —.; Power · · · ·. The left portion represents the effect when the lower carbon is positive, the right when the upper carbon is positive.

Fig. 3.

About two years ago, Siemens & Halske conducted a series of experiments on photographic registration in relation to the determination of the variations of light intensity. In the photographs produced direct by the arc, the maxima of intensity due to the positive current were markedly more intense than those of the negative current; but when the lamp was enclosed in a globe, with or without a reflector, the two were found to be nearly equal. This method of photography is extremely valuable, inasmuch as it clearly depicts all the variations, and shows that the light follows

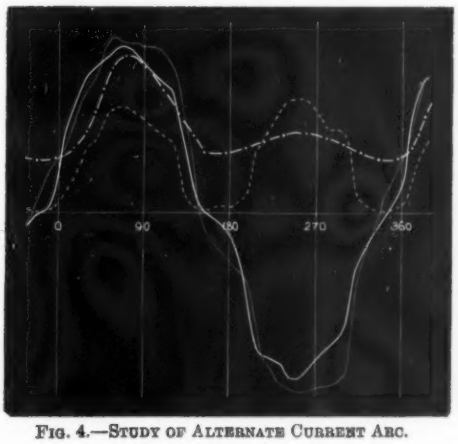


Fig. 4.—Study of Alternate Current Arc.

every change in the current, while the eye at its best can only detect fluctuations when the periods do not exceed about 60 per second.

Blondel's researches were carried out with an apparatus made on the same lines as that of Siemens and Halske. His researches were directed principally to the arc proper, and less toward the radiated light intensity. He endeavoured to ascertain if the arc is really broken when the current is passing the zero point, but the registering photograph only gave a quantitative result. With the apparatus of Oelschlager, charged as suggested by Joost—putting the third branch of a tri-phase motor on short circuit upon itself—the instantaneous value of current intensities of the

voltage and luminous intensity for the three types of curves of a tri-phase motor was determined. These results bear the relation of the figs. 3, 4 and 5. The luminous intensities are taken at the horizontal line, and at 35° above and below this line. In these last two directions the intensities are equal.

In all the curves it is seen that the maximum of light due to the negative current is not much above the minima. In the flattened curve we see, also, that during a long contact with a maximum current, both temperature and light emission are augmented. The difference of phase between tension and current is positive upon the axis of the abscissæ as if produced by self-induction, while between the higher values of the curve this is negative. The curve of the current appears to be in advance of that of the arc, which is explained by the existence of counter electromotive force (thermo-electric) in the arc, between the carbon and the

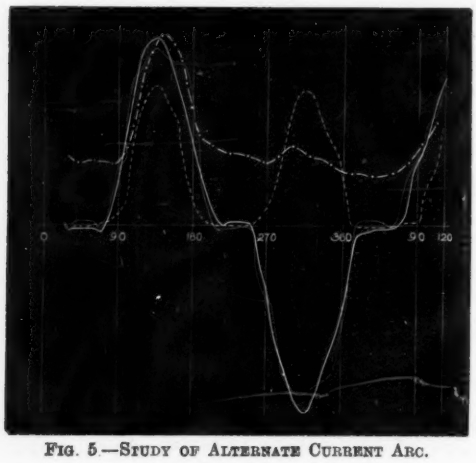


Fig. 5.—Study of Alternate Current Arc.

atmosphere. Thermo-electric forces may, for example, flow from the atmosphere to the carbons. As the maxima are equal, these forces are equal and compensate each other. But now the self-induction of the electro-magnets will act, while with the high intensities one of the carbons being hotter than the other, one electromotive force preponderates, and the current is deflected to the left.

At the end of the reading of the paper some discussion ensued. Amongst those who spoke was Dobrowolsky, who called attention to the fact that the current curve showed no break, and Gorges concurred in the opinion that the arc is constant. Weber, however, demurred, and expressed his opinion that much depended on the grade of the carbons. It is to be hoped that Gorges will shortly publish some details of his own experimental work, for we understand that he has been making a special study of the alternate arc for some years.

RECENT RESEARCHES ON THE RÖNTGEN RAYS.

M. Guillaume gives, in *La Nature*, an account of recent work, principally by French savants, on the X rays. He by no means underrates the work done by his countrymen in this field. He says: "Although we have followed in France the work of foreign investigators on the discharge in gases, we have ourselves, for some years, made but feeble contributions to this subject; the scene is changed; everywhere we are at work, and it will be from France, this time, that the general idea will start, which is to connect the new discovery to known phenomena."

According to M. Guillaume, the work of Röntgen is being extended in three distinct directions. In the first place, attempts are being made to discover the properties of the new rays, either for the purpose of utilising them, or for the purpose of discovering their true nature. In the second place apparatus for producing them and utilising them are being perfected, so as to obtain new effects; in this direction great progress is being made. Lastly, investigations are being made as to the source of the different rays of the vacuum tube; and what is most surprising, it has been found that rays having these marvellous properties constitute a by no means exceptional phenomenon.

The experiments of Röntgen concerning refraction and reflection of the X rays have led to some doubtful results; notwithstanding a certain number of experiments made since then, they still remain so to-day.

As to reflection, several most careful observers have arrived at frankly negative conclusions. With the longest exposures they have not been able to obtain the least trace of an impression, when they have tried to reflect the rays on to a photographic plate by means of a polished metal mirror. In some cases the plate has been found impressed. M.M. Imbert and Bertin-Sans, at Montpelier, M.M. Batelli and Garbasso, at Pisa, think that they have shown by their experiments that the X rays undergo a kind of diffuse reflection upon certain surfaces.

The arrangement used by the Italian physicists is illustrated in fig. 1.

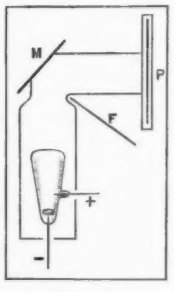


Fig. 1.

The vacuum tube is placed inside a tube of zinc, bent at right angles, and at the elbow of which a metallic mirror, M, is fixed. Opposite the other branch of the tube is placed a photographic plate, P, in its dark slide; for greater security, a thick sheet of metal, F, screens the plate from the direct action of the tube on the plate. After the exposure, the plate is found impressed in the whole region opposite the interior of the tube. The effect appears to be distinct; but it is not absolutely convincing. It is known, in fact, that the compounds of zinc are capable of giving, by phosphorescence, visible or invisible radiations, and it has been known for some time that certain of these radiations traverse bodies opaque to ordinary light. It is possible, then, that the impression on the photographic plate may be due to secondary rays, and not at all to the diffusion of the X rays from the mirror.

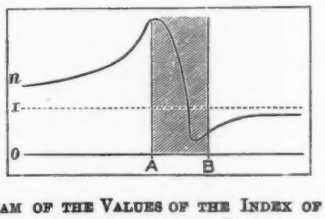


Fig. 2.—Diagram of the Values of the Index of Refraction, n, in an Absorption Band (the Length of the Wave Diminishes from Left to Right).

The refraction of the X rays has been studied with much precision in the laboratory of the Ecole Normal Superieure by M. Perrin. He has found by making use of prisms of aluminium, an index equal to 0·9996. However, this result is not to be insisted upon too much, since it is not altogether free from reproach. For the moment, it would appear to be advisable to interpret it by saying that the index of refraction of the rays in aluminium lies between unity and a number to be afterwards indicated. If it is true that the index is slightly below unity, the new experiments agree with a theory which was in a former article developed by M. Guillaume, and which leads to the view that the new rays are luminous vibrations of very small length of waves. Fig. 2 represents, in fact, the variations of the index of refraction across a band of absorption limited at A and B. Through the whole band the index is abnormal, and the

absorption band once passed, it rises asymptotically to unity.

M.M. Benoist and Hurmuzescu, at Paris; Dufour, at Lusanne; J. J. Thomson, at Cambridge; Righi, at Turin; and other observers have announced that the X rays, falling upon an electrified body, discharge it rapidly. Fig. 3 is a view of the apparatus which has been used by M.M. Benoist and Hurmuzescu in their qualitative experiments made with a view of studying this property of the rays.

A gold leaf electroscope is enclosed in a brass box, the anterior side of which, facing the tube, is made of a thin sheet of aluminium. The opposite face is transparent; it is furnished with a scale which serves to measure the angle of separation of the gold leaves. The observations can be made roughly by a mirror, M, the observer standing near the coil; or, with greater precision, by a telescope, L. The whole apparatus, including the insulators, is enclosed in a metallic case in such a way as to completely exclude all electrostatic effects, except those that are desired to be measured. The face opposite to the apparatus generating the rays consists only of a dielectric, which is quite good enough for approximate researches.

With the help of this apparatus, it is possible to study several of the factors which influence the rapidity of the discharge of bodies by the X rays; the quality of the tube, the manner in which it is excited, the nature of interposed

Three distinct series of researches can be undertaken by the help of this apparatus. It will be convenient in the first place to see whether the nature of the metal forming the receiver for the rays has any influence on the leakage of electricity. M.M. Benoist and Hurmuzescu concluded from some preliminary experiments which they made, that the nature of the receiver was without sensible action upon the rate of discharge; but more precise researches have shown that the discharge augments with the opacity of the body for the X rays. The effect is more considerable also with two thin sheets superposed than with only one sheet. In the second place, the absorption of the rays in plates placed in front of the receiver, and which intercept a part of the flux of energy emanating from the tube, may be studied. The study of the transparency of bodies is more rapid and precise by this method than by the photographic method. Finally, the influence of the surrounding medium upon the rapidity of the discharge of the electrometer may be studied.

The short duration of each experiment allows a series of comparative researches to be made, while the action of the tube remains sensibly constant, which is a necessary condition for obtaining results of any value.

Two factors, in fact, have an influence upon the phenomena to which the rays give rise; their intensity varies with different tubes, they change with time, and they are altogether

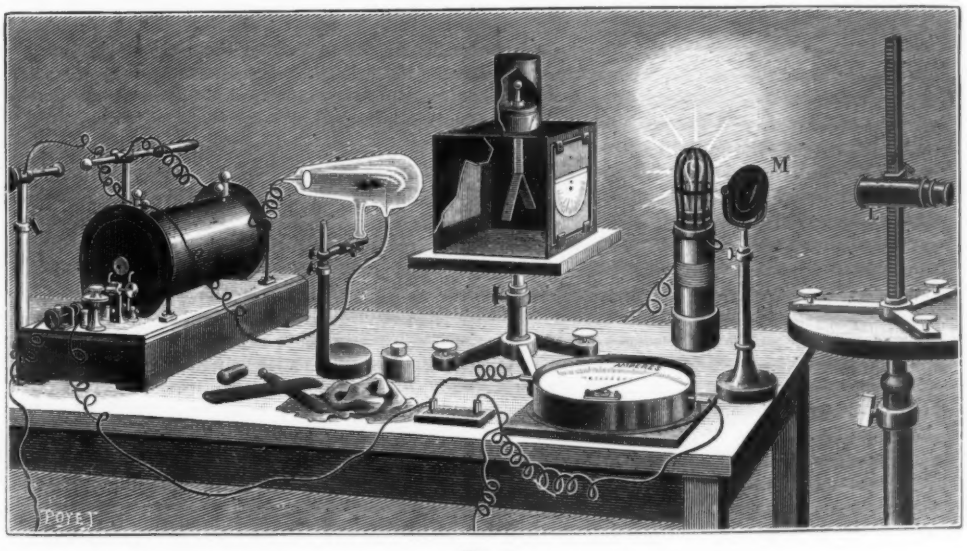


Fig. 3.

media, &c. This process is of very great utility; it is rapid, and of easy execution. Although it may not yet be possible to define the relation which exists between the electric action of the tube and its photographic action, it is very probable that those two actions are sufficiently similar that, within certain limits, the one may be taken as proportional to the other. It is known that these tubes change with time, and it is, therefore, of great interest to find out beforehand the best time of exposure required to obtain irreproachable pictures. The electroscope will furnish this information in a few seconds, and will thus become a valuable indicator to operators desirous of getting good results without leaving too much to chance. It is convenient, however, in order to obtain veritable scientific data about this phenomenon, to replace the electroscope by an electrometer such as that represented in fig. 4.

Here, the receiver of the rays is perfectly definite; it is a metal plate, P, placed behind a circular window in the brass box, closed by a sheet of aluminium. The receiver is connected to the fixed needle, E, of the electrometer, whilst the movable needle situated above the former is put to earth, as the cage is also, by the suspending filament, which is of metal. The stem to which the movable needle is fixed carries a little mirror, of which the position can be read upon a semi-transparent scale. The posterior window, covered with glass, can be so reduced in size that the protection from external electrical influence is perfect.

different, according to the mode in which the tube is excited. Moreover, the rays do not form a homogeneous beam; they are not *monochromatic*. M.M. Benoist and Hurmuzescu have shown, in fact, that, according to their method of production, the X rays possess, in different degrees, the power of discharging bodies. In other words, the residue measured behind the same screen is not a constant fraction of the incident flux. For instance, after passing through a sheet of aluminium 0·1 mm. in thickness, the intensity of the rays is reduced to a fraction, varying from 0·8 to 0·9 of the original flux.

The data, therefore, which may be supplied as to the transparency of bodies, should refer to a well defined quality of rays, otherwise they will be of very little value. It is without doubt mostly for this reason that the results found by different observers are so divergent.

Röntgen, while admitting the preponderating influence of the density upon the absorbing power of bodies, has already pointed out in the comparative table inversions of the two properties. Batelli and Garbasso, on the contrary, who have studied a large number of bodies, think that the order of the densities is rigorously the same as that of the opacities. They have unfortunately left on one side some bodies, which really destroy the harmony of the table. Thus, lead glass, fluorspar quartz, the densities of which are close to that of aluminium, are much more opaque. For these bodies the transparency to the X rays is exactly opposite to that which

they present to the eye, so that an object composed of lead glass and aluminium placed side by side projects, with ordinary light, a shadow which is exactly the opposite of the shadow produced in the X rays.

The opacity of certain bodies to the X rays forms an easy means of identifying them. Thus Gascard and Buguet have found that diamonds are much more transparent than their imitations. The same is true for jet and other stones employed in jewellery.

According to M. Meslans, carbon is very transparent, as well as all its purely organic compounds; but the addition of a mineral element, metal or metalloid, increases their opacity considerably. It appears that this is due to a certain atom in the molecule, which imports into all its combinations the property of absorbing the X rays; thus lead and its compounds remain opaque in all possible combinations, and it is to its presence that crystal glass owes its great opacity; this latter substance is incomparably more opaque to the X rays than other glasses of the same composition except that they contain no lead.

According to Prof. J. J. Thomson, of Cambridge, the property which the X rays possess of discharging electrified bodies is due to the fact that they make the surrounding medium a conductor. This quality of the medium persists during a short space of time. This is shown by directing upon the electroscope the air which has been traversed by the rays. The discharge still takes place, which shows that the gas has experienced a modification of a chemical nature.

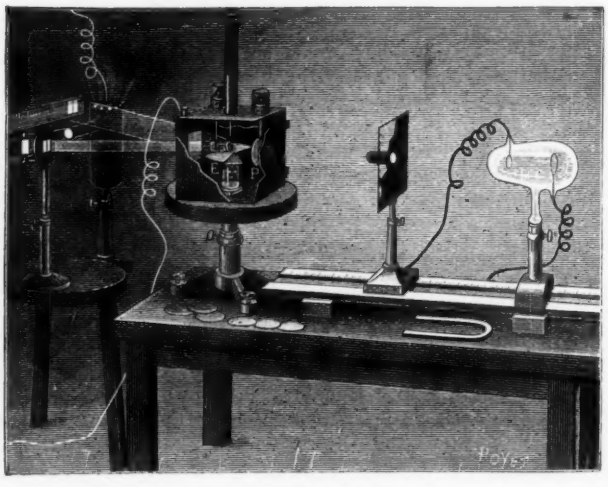


FIG. 4.—PERFECTED APPARATUS FOR MEASURING THE ELECTRIC ACTION OF THE X RAYS.

Some other experiments lead to the belief that the gas has been ionised by the action of the rays; its molecule has been broken up into its constituent atoms, and the atom travelling alone neutralises the charges of neighbouring bodies.

This dissociation is not limited to gases; under the action of the rays, paraffin, and sulphur, become for the moment conductors, and equalise the potential of bodies completely immersed in their mass.

These phenomena are not without analogy with certain other phenomena which have been known for some years. It is known that ultra violet light discharges electrified bodies, and the mechanism of this action has been found either in the pulverisation of the metal by this particular light, or in decomposition of the surrounding gas. The first opinion has been put forward by Lenard and Max Wolf, who have tested it by some very ingenious experiments. The second theory is that of Arrhenius, who has supported it by some good arguments. It is, therefore, probable that the two actions are superposed to produce the observed effect.

It should also be remarked that this variation of the conductivity of the metalloids under the action of the X rays presents a striking analogy with the phenomena which take place in fused selenium, which up to the present were somewhat isolated, at least, as far as solids are concerned.

It has been seen that the X rays possess a certain number of properties which at first strike us as being of inexplicable singularity. However, a more attentive examination shows that they are those of a certain kind of light, with a somewhat greater intensity.

Oscillations of very short wave length ought to traverse all bodies; in fact, when the length of the wave approaches the size of the molecule, matter appears for the movement of the ether with a certain discontinuity, and the wave traverses it without much difficulty. At the same time absorption, reflection, and refraction, ought to disappear.

Finally, Galitzine and de Karnojitzky have succeeded with an experiment that Röntgen attempted with negative results. On passing the X rays through crossed tourmalines, the Russian physicists have observed a well marked diminution of the action of the rays. They conclude from this that the rays are polarisable, and that the direction of the oscillation is transversal.

CORRESPONDENCE.

The International Telegraph Conference of 1896.

The interesting note on the "International Telegraph Conference of 1896," which appeared in your issue of April 10th, leaves the reader under the impression that the tariff reform proposed by the German administration would be most beneficial to the Government systems, and that the cable companies alone must suffer the losses it involves. For many States the prospects foreshadowed in this scheme are not less gloomy than they are for the companies. The reduction of the terminal rates, and the partial suppression of the transit charges which the German proposal puts in view, will certainly not increase the revenue from European traffic, and, consequently, will not meet with the approval of all the delegates to the conference. It is to be presumed, therefore, that the German scheme will not be so enthusiastically welcomed as your article would lead us to believe. As to the simplification of accounts and unification of rates, it does not present such a degree of perfection as would induce the Governments to joyfully undergo all the financial sacrifices which it claims from them. The views of the delegates will, I venture to say, be somewhat divided upon this point.

As to the centralisation of the international telegraph system proposed by you, it would certainly be the easiest solution of the problem of unification of the European rates, but your proposal is, I fear, rather utopian than practical. The European political constellation is not so constituted as to allow of the fulfilment of such a grand scheme. Progress of this kind cannot be realised immediately, but can only be brought about gradually, and after it has passed through many stages of developing process.

Another proposal which was submitted a short time ago to the different European telegraph offices, would, for the time being, solve the question in a better and more satisfactory manner. It forms, I should say, a link between the German scheme and that set out in your valuable journal. As your readers may be interested in the outlines of that novel scheme, I beg to enclose a copy of the proposal which I have lately received from a friend in Switzerland.

With apologies for the length of this letter.

W. H. Mole.

[We have taken the liberty of slightly altering Mr. Mole's letter in a way which in no sense alters his views on the subject, but we publish his letter, because his enclosure, with which we shall deal in a future issue, appears of value on an interesting subject from the telegraphic public point of view. —EDS. ELEC. REV.]

Drum Armatures.

Would you kindly inform me through your Correspondence columns as to whether it is of any advantage to insulate a drum armature from the spindle? Also, if it were not insulated, would it give rise to more eddy currents cir-

culating in the polar masses than if it were insulated therefrom? I should be very much obliged if you would help me out of this little difficulty.

Giraldus Jones.

Cardiff.

[We take it that our correspondent means to enquire whether it is any advantage to electrically insulate the *core* of a drum armature from its spindle. Generally speaking, it is not worth while to do this, as although there would be a *very* slight reduction in eddy current loss, the disadvantages, consisting principally of the reduction in mechanical strength, would far more than balance the gain.—Eds. Elec. Rev.]

LEGAL.

Electric Construction Company *v.* South Staffordshire Tramways Company.

In the Chancery Division of the High Court of Justice, on Saturday, the 25th ult., the trial of this action came before Mr. Justice Romer.

Counsel for the plaintiff corporation were Mr. Eve, Q.C., and Mr. Theobald; Sir F. Lockwood, Q.C., M.P., Mr. Oswald, Q.C., M.P., Mr. Jenkins, and Mr. T. D. Munns, appeared for the defendants.

In opening the case Mr. Eve, Q.C., said the action was brought for the payment of sums due under an agreement entered into between the plaintiffs, who were the reconstructed company, and the defendant company, in February, 1892. There had been a defence, and several amended defences, put in, but the last defence put in came to this, that the agreement was under circumstances so tainted with fraud, that the Court would not enforce specific performance. In their counterclaim the defendants set up that the agreement was not binding on them, and asked for rescission, other relief, and damages. So far as the plaintiffs were concerned, there was the admitted agreement and the execution, and one might rest there and leave the defendants to make out their counterclaim, but that would be obviously inconvenient, seeing that several persons who would be called as witnesses were accused of fraud, and therefore it was necessary to go into the matter and see what the agreement really was. The defendant company was incorporated under a special Act passed in 1889, and were the successors of a limited company, which was incorporated early in the eighties for the purpose of acquiring the benefit of certain provisional orders for the construction of tramways in Staffordshire, and their maintenance. Under the provisional orders, the tramways were made in 1883. The original idea was that some sections of the tramways should be worked by horse-power, and other sections by steam-power, and for some considerable time subsequent to 1883 that idea was carried out. In order to enable the limited company to work by steam, it was necessary to acquire licenses from the local authorities, and these were granted for limited periods that were from time to time renewed; but in 1888, after two years' working, the local authorities intimated they could not longer grant the licenses for the working of those sections worked by steam unless the whole working plant and mode of working was altered. The fact was that the company had adopted an antiquated form of engines, the permanent way was not properly kept in order, accidents had happened, and the authorities were compelled to intimate that they would have to interfere. There was no doubt, therefore, that as early as 1888 the company was told they must get some other system. Under these circumstances, the limited company, which had raised all the moneys it could possibly raise by preference shares and debentures, was at a loss to know what to do, and it was considered necessary or desirable that the limited company should be dissolved, and that a statutory company, formed for the purpose of acquiring the assets and liabilities of the limited company, and (if possible) devise some other means of working. In 1888 a Bill was accordingly promoted for incorporating the defendant company and dissolving the limited company. That Bill being introduced late in the session did not pass, but it was re-introduced, and passed in August of the following year. The Act recited the formation of the limited company for the purpose of working trams, and the issue of certain preference shares. There was £256,360 of ordinary shares, £75,900 of preference shares, and £33,920 of 5 per cent. debentures issued. In the Act there was a recital to the effect that all the tramways had been constructed, and that the undertaking was vested in, and worked by the limited company. Under further orders further trams were constructed, and the limited company was dissolved, its liabilities being imposed on the incorporated company, and its capital reduced to about one-half, viz., £86,580 of preference shares and £129,650 of ordinary stock. The borrowing powers were not to exceed £50,000. The company being face to face with the fact that the permanent way was out of order, the engines of antiquated construction, and there being difficulties in the way of the weight of the cars, had to set about seeing what form of motive power they should substitute for the steam power. At this time there had been introduced a system of working tramways by means of overhead electrical works, and other electrical appliances, and on October 17th, 1889, at a board meeting of the company held at Darlaston, it was agreed to invite tenders for the supply of traction power and maintenance. In May, 1889, a company was registered for the purpose of introducing the system of electrical working into this country, and that was the first-named plaintiff company in the action. This company was formed with a capital of half a million sterling, in 50,000 shares of £10 each. Mr. Joseph Smith, who subsequently changed his name to Ebbsmith, was the managing director. Previous to 1888, Mr. Ebbsmith was a member of a firm of solicitors acting for the South Staffordshire Company, and he was the person who engineered the Bill through Parliament. The works' director was Mr. Thomas Parker, and the engineering adviser of the company Mr. Carruthers Wain. By one of the amended defences, it was suggested that this company was got up for the purpose of foisting the undertaking on the defendant company, or to bleed the defendant company in the matter of the traction part of the undertaking. One of the equities relied upon against the plaintiff company was that Mr. Spencer Balfour and Mr. Carruthers Wain were founders of the company. The company was floated, and ultimately the agreement of February, 1892, was made. In March, 1895, the plaintiffs, under a clause in the agreement, elected to determine, and if the notices given were valid, then the plaintiffs were entitled to the sums they sued for, and a declaration that they were entitled to determine the agreement.

Mr. Justice Romer inquired whether the defendant company had been wound up.

Mr. Eve said it had not; when the petition came on, the petitioners were paid off, upon an understanding that the matter should be raised in an action.

Mr. Justice Romer intimated that, in his opinion, if the plaintiffs were so greatly interested, it would have been to their advantage to carry on the business.

Sir. F. Lockwood said he had already made an offer, and he thought there ought to be the same *modus vivendi* that would put an end to the action.

At this juncture Mr. Justice Romer having said that he should not have made any suggestion, only he saw that the plaintiffs were very largely interested in the working of the company, the parties and counsel consulted for some 55 minutes with a view to a settlement.

It being found impossible, however, to come to an arrangement, the hearing of the action was proceeded with, Mr. Eve, Q.C., reading the correspondence.

The hearing was adjourned for the day.

Second Day.—Monday, April 27th.

Mr. Eve concluded his opening of the plaintiffs' case, and evidence was given in support of it by Mr. J. Irving Courtney, a director of the plaintiff company; Mr. Alfred Dickinson, an engineer; Sir Henry Mance, a former director of the plaintiff company; and Mr. Gray, secretary of the plaintiff company.

Third Day.—Tuesday, April 28th.

The Defence.

In opening the defence, Sir F. Lockwood said his contention would be that in the negotiations which led up to the contract of February 26th, 1892, the interests of the South Staffordshire Company were betrayed, and the interests of the plaintiff company ignored. The view he presented to the Court was that the beneficial nature of this contract to either the plaintiff or defendant company was absolutely ignored, and the only object was to capture the South Staffordshire Tramways Company and its advantageous concessions. There could be no doubt that the concessions were advantageous because the tramways were in the Black Country, and were to run through Wednesbury, Darlaston, Walsall, and West Bromwich, which teemed with population of a kind which would recognise the benefit of cheap conveyance. There could not be a shadow of a doubt that if the Tramways Company had been directed by honest men, and had had fair play, it would have been a very successful company. It had not had fair play; it had not been in the hands of honest men. He dared say that his learned friend would be willing to concede so much, but it was not enough for him to establish so much—what he had to do was to satisfy the Court that in the negotiations for the contract the interests of the company were not only betrayed by those who were representing it, but the interests of the plaintiff company were entrusted to one who knew perfectly well how the South Staffordshire Company was being treated. The position of the plaintiff company, he took it, was this, so far as its directors were concerned—if they should have employed as their agent a person who was perfectly cognisant of the fraud which was being practised on the South Staffordshire Company, it might be they could not be held responsible in damages in respect of the fraud of their agent, but it was perfectly clear they could not avail themselves of any contract entered into under such circumstances. He admitted that he had to satisfy the Court that Mr. Ebbsmith in this matter was the accredited agent of the plaintiff company. It was not necessary to establish that Ebbsmith was the sole agent, but it was necessary to establish that but for the interference of Mr. Ebbsmith this contract would not have been brought about. With a view of showing what happened in negotiating for the contract, the learned counsel said that the relations between these men had already formed the subject of judicial investigation. In February last an action was tried before the Lord Chief Justice and a special jury, in which claims were made against Mr. Ebbsmith and Mr. Wain, charging them with having conspired together to defraud the Staffordshire Company. The story of their fraud, as proved, was this: When the South Staffordshire Tramways Company came into existence in 1882 or 1884, Mr. James Carruthers Wain was appointed chairman. There were two other directors, who apparently took very little part in the management of the company, and Mr. Ebbsmith acted as solicitor of the company. Shortly after the Tramways Company came into existence, it occurred to the mind of Mr. Ebbsmith that a considerable sum of money might be made out of the company by supplying the various appliances necessary for the development and continuance of its business. Accordingly, he obtained

certain patents belonging to Mr. Alfred Dickinson, and in 1887 formed the Dickinson Appliance Company, with a share capital of 1,507 ordinary shares, of which he had 1,500, and his clerks the odd seven. The offices were the offices of Ebbsmith, and one of his clerks was the secretary. The Dickinson Appliance Company made various contracts with the South Staffordshire Company for the supply of appliances necessary to carry on the business of the company. Mr. Ebbsmith then purchased 13 acres of land for £1,000, and leased 2½ acres of it to the Dickinson Company at a ground rent of £365. The company assigned the lease to the South Staffordshire Company at a premium of £100, and subsequently the reversion was sold to the South Staffordshire Company by Ebbsmith for £7,000. All this time there was a running accompaniment of costs. It was hardly necessary to say that the South Staffordshire Company's shareholders did not flourish, and it occurred to Mr. Ebbsmith that it would be well to obtain the power to introduce electricity as a motive power. This required Parliamentary powers, and the necessary resolution was carried at a meeting packed by Ebbsmith and Wain with persons who were entertained out of the South Staffordshire Company's moneys. Then Mr. Ebbsmith, with the assistance of Mr. Jabez Balfour, promoted the Electric Construction Company, and the first matter to come before the board was the contract in question. This was the short history of the unfortunate South Staffordshire Company.

Evidence was then given for the defence by Mr. Thomas Parker, an electrical engineer, of Wolverhampton; Mr. John Richard Cooper, Town Clerk of Walsall; and Mr. Wm. E. Kenway, civil engineer.

The hearing of the case was then adjourned until Thursday.

THE LONDON ELECTRICAL SUPPLY CORPORATION *v.* PRENTICE.

IN the Westminster County Court, on Wednesday, the case of the London Electrical Supply Corporation, Limited *v.* Prentice came before his Honour Judge Lumley Smith, Q.C., and was a claim for £15 as damages for breach of contract.

Mr. STEPHEN LYNCH, plaintiffs' counsel, said the plaintiff corporation was engaged, under the contract produced, to fix the electric light at the house of defendant, a member of the Stock Exchange, at 60, Park Street, W. After signing the contract, defendant said he did so under a misapprehension, and plaintiffs were not permitted to carry out the contract.

Evidence was given bearing out that statement, and to the effect that the claim was made up of three items: loss of profit, £10; three plans, £1; and the loss of men's time, £4. It was admitted plans had to be made and submitted to the County Council before the mains were laid, and that plaintiffs had an agreement with the Westminster Company, in the words of defendant's counsel, "not to try and steal each other's business." It was also admitted that the Westminster Company had supplied the former tenant at the house. His Honour's suggestion that a settlement should be arrived at was abortive, and for the defence it was stated that the defendant left the matter with Messrs. Lawson and Warner, agents, for them to arrange with the Westminster Company to re-connect the house with their mains. A canvasser called upon defendant from plaintiffs with a contract, which he signed under the impression that it was with the Westminster Company, who had now carried out the work.

Mr. LYNCH mentioned that the Westminster Company had not complained.

His HONOUR thought from the evidence and correspondence that the Westminster Company had acted as fairly as any company could. The contract was for work which the Westminster Company had now done. He believed defendant signed the contract with plaintiffs under a misapprehension, and gave judgment for the defendant, with costs.

ACTION AGAINST THE CENTRAL LONDON RAILWAY.

AT the Sheriff's Court, Red Lion Square, last week, before the Under Sheriff, the compensation case, the Kensington Woodhouse Park Syndicate, Limited, who are the proprietors of Woodhouse Park, against the Central London Railway Company was resumed. The claim has been before the Court a considerable time, and was brought to a conclusion on Saturday, the jury awarding to the claimants the sum of £4,950 and costs.

BUSINESS NOTICES, &c.

Application re Design Registration.—In the Court of Appeal on Friday last, before Lords Justices Lindley, Lopes, and Kay, Messrs. Julius Sax & Co., Limited, electrical engineers, appealed from an order of Mr. Justice North, dated February 8th, who dismissed a motion asking for the rectification of the register of designs by striking off design No. 206,807, registered by J. F. Clarke, on the ground that it was not novel, and that similar designs had been used before. The design consisted of a lamp used for an electric light to light shop windows, and was similar to lamps that had been previously used for gas. Their lordships, in the result, reserved judgment.

Change of Address.—The India Rubber, Gutta Percha and Telegraph Works Company announces that its Newcastle branch has been removed from 6, Neville Street to 59, Westgate Road.

Electrical Wares Exported.

WEEK ENDING APRIL 24TH, 1895.	£	s.	WEEK ENDING APRIL 24TH, 1896.	£	s.
Amsterdam	70	0	Adelaide	3,222	0
Algoa Bay	20	0	Amsterdam	50	0
Buenos Ayres ...	431	0	Beira	17	0
Brisbane	39	0	Calcutta	33	0
Calcutta	61	0	Cape Town	318	0
Cape Town	885	0	Delagoa Bay	100	0
Cussack	14	0	Demarara	78	0
East London ...	741	0	Durban	42	0
Gothenburg	20	0	Melbourne	50	0
Halifax (cable) ...	230	0	Port Elizabeth ...	28	0
Melbourne	102	0	Piræus	25	0
Marseilles	100	0	Shanghai	110	0
Otago	12	0	Singapore	40	0
Port Natal	12	0	Stockholm	371	0
Rosario	206	0	Sydney	387	0
Revel	194	0	Wellington	296	0
Santander	25	0		5,167	0
Sydney	41	0			
St. Kitts	56	0			
Shanghai	120	0			
Singapore	155	0			
Timaru	100	0			
Yokohama	258	0			
	3,942	0			

Foreign Goods Transhipped.

	£	s.		£	s.
Madrid (Electric light meter)	144	0	Brisbane	288	0
Madrid (Electric light machinery) ...	68	0			
Venice (Electric light machinery) ...	66	0			

Bankruptcy Proceedings.—At the London Bankruptcy Court last Tuesday, George Fredk. Rogers, electrical engineer, 5, Great Winchester Street, E.C., applied for an order of discharge. He failed in March, 1895, with ranking liabilities £19,900, and assets that have realised £496 13s. 3d., sufficient to pay a dividend of about 6d. in the £. The failure was attributed by the bankrupt to his liability on accommodation and other bills for which he received no or only part consideration; to loss on trading and investments; to law costs and bad debts; and to depreciation in the value of securities deposited with creditors. Several offences were reported by the official receiver, and the discharge was suspended for three years.

An application was made to Mr. Registrar Brougham, sitting at the London Bankruptcy Court on April 23rd, for an order of discharge on behalf of Arthur Hale, medical galvanist, lately trading at 105, Regent Street, W., as Hale & Son. Insufficiency of assets to show 10s. in the £ on the liabilities, and trading with knowledge of insolvency were reported as offences, and the discharge was suspended for two years.

Liquidation Notice.—At meetings held on April 9th and 24th, 1896, at 7, Poultry, E.C., the Tramways Electrical Traction Company, Limited, resolved to wind up voluntarily, Mr. J. B. Glenn being appointed liquidator.

Dissolution of Partnership.—The partnership hitherto existing between A. J. Shirley and T. R. Spence, carrying on business as art metal workers, at 45, Rathbone Place, Oxford Street, London, has been dissolved by mutual consent. A. J. Shirley, who will attend to the late firm's debts, will also continue to carry on the business under the same style as formerly.

Catalogues.—We have received a list marked "supplement," of the I.E.S. accumulator, explaining the general formation of the cells and details, and giving in table form the weight, rates of charge and discharge, capacity, size, price, &c., of the various types.

From Messrs. D. Stewart & Co., of London and Glasgow, we have received a neat little pamphlet giving particulars and a few illustrations of the "Simplex" patent ice-making and refrigerating machinery.

A catalogue of electric light fittings designs has been issued by Messrs. F. & C. Osler, of Oxford Street, W. There are some very elegant pieces of work in ornamental pendants, ceiling lights, and brackets. There are also some nice specimens of standard and table lamps with shades, French bronzes, some exquisite prints from photographic blocks from drawings of electroliers, in crystal and polished metal work, of Queen Anne, Louis XIV., and other styles. A few pages of sundries and ornamental shades complete the book, which is a very neat and nicely printed production in stiff covers.

Change of Name.—We are asked to state that in future the business of Ashton, Green, Mathews & Co., of 61, St. Mary Axe, E.C., will be carried on under the style of Ernest Mathews & Co. Mr. Ernest Mathews has, for several years, been the sole proprietor of the business, and all accounts outstanding in the name of Ashton, Green, Mathews & Co. will be paid by the firm of Ernest Mathews and Co.

Literary Announcement.—A new work, by Mr. Wm. Ackroyd, on the X rays, and entitled "The Old Light and the New," will be published in the first week of May by Messrs. Chapman and Hall, Limited. It deals largely with the chemistry of colour in its relation to the Röntgen light, and incidentally establishes a new law.

It will be an important contribution towards settling the dispute as to the nature of the X rays. The book will be illustrated by diagrams and photogravures, and will be issued in cheap form.

New Branch.—The Yost Typewriter Company, Limited, owing to increased business, have found it necessary to open an additional branch at 50, Dean Street, Newcastle-on-Tyne.

Power Computers.—We have received from Mr. Charles N. Pickworth one of his power computers for gas and oil engines. Although specially intended for calculation relating to the brake and indicated horse-power of gas and oil engines, this computer is equally useful for the similar calculations needed in connection with the steam engine; while its further application to problems relating to the speed and diameter of pulleys, belt velocities, &c., should add to the general utility of the instrument. Although only of card it is remarkably accurate, the scales having been printed in a special manner from engine divided and engraved plates. This exceedingly useful article may be procured from Mr. Pickworth at 17, Lancaster Road, Fallowfield, Manchester.

Queen Anne's Mansions Lighting and Heating Company, Limited.—According to notice in the *London Gazette*, a meeting of the holders of an issue of £43,000 debentures, secured by Trust Deed, September, 1891, will be held at Winchester House on May 4th for the purpose of approving and declaring to be binding upon themselves an agreement between H. R. Savory, F. W. Reynolds, of the first part; the company of the second part; E. H. R. Trenow, the receiver and manager, of the third part; holders of the preference shares of the fourth part; and W. R. Renshaw of the fifth part; this agreement being supplemental to one dated May 16th, 1895.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The question of lighting the Palace Hotel is under consideration, the supply to be taken from the Corporation mains.

Battersea.—The result of the competition for the best method of dealing with a public supply of electricity in Battersea has now been announced. It will be remembered that in September of last year, the Vestry invited competitive schemes for the lighting of the parish by electricity, and for the utilisation of the dust destructor in connection therewith. With this object instructions to electrical engineers were prepared, and premiums of £50, £30 and £15 respectively, were offered for the best three schemes submitted, it being stipulated that the schemes finally selected should become the absolute property of the Vestry. It was the intention of the Vestry to select the scheme, &c., in all respects the best, and in the event of the Vestry accepting the contract, it is their intention to employ the successful competitor as engineer, provided that he produces evidence satisfactory to the committee of his competency to carry out the work, and in that case the premium will merge into and form part of the commission or remuneration of the successful competitor. The "Instructions" were duly issued to 28 applicants, and in response thereto, 21 sets of schemes were submitted by December 12th. These were opened by the committee on the following day. At this stage the Electric Lighting Committee, pursuant to the authority of the Vestry, appointed Mr. Robert Hammond, M.I.E.E., as the expert engineer to advise the committee, and to report on each of the schemes submitted. Mr. Hammond's report was a very lengthy document, comprising upwards of 200 pages of closely type-written foolscap. Each scheme was carefully analysed on a uniform basis, and the estimates dissected in a similar manner, the comments and criticisms of the expert following in the same order. By this arrangement an easy comparison was afforded, while the comprehensive tabulated summary gave a succinct account of the whole of the schemes. Mr. Hammond's report as to the relative merits of these schemes was fully considered by the committee, and in accordance with his recommendation, the premiums last week were allotted by the Vestry as under:—

Mark of scheme.	Amount of prize.	Name of winner.
1st J.	£50	Mr. Dawbarn, on behalf of The Brush Electrical Engineering Company, Limited.
2nd M.	£30	Mr. W. Best.
3rd F.	£15	Mr. J. Hardie McLean.

The above-named schemes were referred back to the committee, who have instructions to prepare a scheme for dealing with the electric lighting of the parish, and to submit same to the Vestry at an early date. The Vestry, at their meeting, also adopted the recommendations of the Electric Lighting Committee in respect to the lighting of the Town Hall by electricity, and have decided to put the work in hand at once. Mr. Hammond, who submitted a lengthy report upon the matter, has been appointed as the consulting engineer to carry out the work at a fee representing 5 per cent. upon the capital outlay. It is estimated that the cost of the scheme will be about £3,000. Application will be duly made to the London County Council for a loan of £3,000 for the purpose of defraying the cost. The generating works for the Town Hall lighting will be erected on the vacant land at the rear of the present buildings. The award of the premium to Mr. Dawbarn will doubtless carry with it the appointment of consulting engineer to the Vestay. We may also mention that the premium secured by the Brush Company at Winchester, was also due to Mr. Dawbarn.

Bearpark.—The Parish Council has just signed an agreement for lighting the parish with electricity.

Belfast.—Last week the engineer submitted to the Electric Committee his report upon the available sites for the generating station on a large scale, including two or three pieces of Corporation property, one of which, abutting on the river, is likely to be selected.

Blackpool.—A Local Government Board inquiry was held on 28th ult. into the application of the Corporation for permission to borrow a sum of £30,000 for electric lighting purposes.

Cleckheaton.—At the general meeting of the Co-operative Society a prolonged and animated discussion ensued on the question of lighting up the Central Stores with electricity. The estimated cost of the installation was stated at £800 to £1,200, and 50 votes were recorded in favour of electricity to 51 against. Consequently the proposal was defeated.

Cotton Mill Lighting.—Mossfield Mills, belonging to Messrs. J. Knowles & Son, Bolton, are being fitted throughout with electric light by Messrs. W. Banks & Co., Limited, of Bolton.

Dundee.—The Board of Trade report regarding the recent accident at the electric lighting station has been received by the Council. Mr. A. Watt, engineer surveyor-in-chief to the Board of Trade, states that the explosion was due to the expansion and contraction of the main steam pipe, causing undue strain to be put on the cast-iron bend. There was also considerable vibration of the pipes, and the metal was of a spongy nature. After some general remarks with reference to the accident, the report proceeds that, on inspection of the pipe which fractured, Mr. Watt found it had been broken close to the flange, and that the metal at the fracture appeared to be spongy. The main steam pipe was well supplied with steam traps, and in addition to the one on the branch pipe, there was a half-inch drain cock in the bottom of the slide valve casing, and as the engine had been working for about four hours previously, it was not probable that there would be an accumulation of water in the pipes to cause a fracture. Mr. Peter Samson, engineer surveyor-in-chief, and assistant secretary of the Marine Department of the Board of Trade, adds that the arrangement of the steam pipes appeared to have been such that any variations in the length of the main pipe due to its contraction or expansion would result in producing severe stresses at the part where the fracture occurred. As the metal appeared to have been of a spongy nature, it was not surprising that an explosion resulted.

Edinburgh.—The Electric Light Committee recommends the reduction of the price per unit for private lighting from 6d. to 5d., and for public lighting from £20 to £18 per arc lamp. These reductions are estimated to absorb £4,000 of the estimated £7,000 surplus.

Greenock.—The Police Board had a discussion *re* extensions to the gas lighting the other day, the Gas Committee having had the matter under consideration. Several members felt that electric lighting should be taken into consideration.

Grimsby.—The Council, on the 28th ult., decided to make application in November for a renewal of the electric lighting provisional order for another three years, and a deputation is to inspect the electric light installations in other towns.

Halifax.—A Local Government inquiry was held on 22nd ult. respecting an application by the Corporation for sanction to borrow £20,000 for the purposes of electric lighting. The Corporation had previously obtained borrowing powers for £39,950 for the purposes of electric lighting, but up to the present £43,355 had been expended. The Corporation were already supplying 12,000 8-C.P. lamps, and the demand was rapidly increasing. The existing installation had not yet paid its way, the loss last year, including interest, being £1,030. It had, however, been in existence only 15 months. Councillor Hebden opposed the application because there was no provision in the loan for developing electricity as a motive power for running machinery. The plant was practically lying idle during the day, but if it were then used the Committee would be able to reduce the price to consumers. He made the suggestion at a meeting of the Town Council, but was outvoted. He contended that £5,000 of the £20,000 should be used for the development of electricity as a motive power.

Hampstead.—Mr. Harold Morton has been appointed assistant electrical engineer in the place of Mr. Bastian, resigned. The engineer has been authorised to obtain meters, cables, testing instruments, &c., required, at an estimated cost of £122 odd, and to drain eight sub-stations at a cost of £24; also to extend the mains along stated thoroughfares at a cost of £570.

Hospital Lighting.—There has just been completed at the Infectious Diseases Hospital, at Lightburn, Shettleston, Glasgow, an installation of 350 incandescent lights of 16 C.P. The generating plant consists of Siemens dynamo, and a set of E.P.S. accumulators. The dynamo derives its motive power from the laundry engine. The contractors for the electric lighting were Messrs. Claud Hamilton, Limited, Glasgow, the work being carried out to the specification, and under supervision of Mr. Wm. A. Bryson, M.I.E.E., of Glasgow.

Islington.—The Electric Lighting Committee is considering, for the purpose of submitting estimates, &c., to the Vestry, what main extensions are necessary or advisable in the parish.

Kingston.—The Town Clerk recently laid before the Lighting Committee the reply of the Malden and Coombe District Council on the question of electric lighting, and he was instructed to refer the District Council to the Electric Lighting Acts, which mentioned 42 years as the maximum period before the option of purchase by the District Council would accrue. The Committee, however, would be prepared to consider the question of somewhat reducing such period. The Lighting Committee estimates the expenditure for the half-year ending September 29th next at £3,780 10s. 11d., and the receipts £1,073 15s. 11d, leaving £2,706 15s. to be raised by rate.

Lambeth.—Again, on 23rd ult., the Vestry met to discuss the electric lighting question. After a protracted discussion, during which a number of amendments were rejected, the matter again stood adjourned.

Lenton.—Some new cycle works are to be erected at Lenton by the Raleigh Cycle Company, of Nottingham. A contemporary says that over 12 miles of telephone wire will be used to place the various departments in direct communication with each other. Arrangements have been made for an installation of electric light at an early period, when it is calculated that over 5,000 incandescent lamps will be utilised.

Leyton.—The erection of the central station is well in hand, and the laying of mains was commenced early last week.

Liverpool.—Major Cardew held a Board of Trade inquiry on 28th ult. into the application of the Liverpool District Electric Lighting Company, for an order empowering them to supply electricity in the districts of Garston and Much Woolton, the Urban District Councils of which had objected to the granting of the order.

Maidstone.—At the District Council meeting last week, Alderman Ellis moved that the terms offered by Mr. King for taking over the provisional order be accepted, and the draft agreement submitted to counsel. After discussion, it was resolved to let the matter stand for 12 months.

Portadown.—At the Town Commissioners' last meeting the chairman said he hoped the Commissioners would shortly see their way to introduce the electric light. Another speaker said that one result of the interview with the Gas Company was that two dynamos had already been ordered, and one of them was large enough to light the town if required.

Portsmouth.—The Council has adopted a recommendation of the Electric Light Committee to extend the low tension electric light mains from Elm Grove, through Yarborough Road, and The Retreat to Grove Road, at an estimated cost of £100.

Shoreditch.—The Vestry last week approved a contract for the purchase of the Christian Institute at £3,750 by the Electric Lighting Committee. The engine house and offices are to be proceeded with very shortly.

South Africa.—From the *British and South African Export Gazette* we learn that Messrs. Findlay & Co,, electrical engineers, Cape Town, have recently installed the electric light into the extensive premises of Messrs. Fletcher & Co., general importers, Darling Street, of that city. Inside the building there are 148 lights of 16 candle-power; and there are five of 150 candle-power outside. —Edison and Hopkinson's dynamos are used for the purpose of lighting the Roodepoort Deep Mine.

Southampton.—A deputation from the Town Council inspected the working of the Portsmouth Corporation electric lighting plant last Friday.

Mr. Manville has been appointed consulting engineer for the carrying out of the works included in his recent report to the Council for a fee of 5 per cent. commission. Mr. Manville asked that Mr. J. G. W. Aldridge be appointed to act conjointly with him, the stated fee to include the services of both. The Council, however, declined to make a joint appointment, though they had no objection to Mr. Manville personally arranging with Mr. Aldridge.

Southport.—On 23rd ult., a Local Government Board inquiry was held into the application of the Corporation for power to borrow £4,000 for electric lighting extensions; 150 consumers are now supplied, £42,000 having already been expended. The proposed extra expenditure will enable the Corporation to supply another hundred customers.

Westminster.—The Vestry has instructed the surveyor to prepare a specification and invite tenders from six firms for remedying the deficiencies in the electric light installation at the baths. About £250 is the estimated cost.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

The Light Railways Bill.—This Bill has been before the Grand Committee on Trade several days this week, amendments being discussed and clauses added.

Bâle Tramways.—After successful operation for over a year of the electric trolley line there put up, it has been decided to equip the remainder of the lines in that town on the overhead system. These extensions will be completed during next year, and are estimated at about £70,000.

Dublin Electric Tramways.—The *Irish Times* says that for some days past quite a number of cars have been running between Haddington Road and Kingstown, at five minutes' intervals, testing the line and the action of the cars, with the most satisfactory results.

The Rathmines, Dundrum and Blackrock Tramway Company want to lay down two miles of electric tramway, on the overhead wire system, in Rathmines, and a deputation recently attended a meeting of the Commissioners and explained the scheme. The Commissioners consented, subject to a number of conditions.

Counsel has advised the Dalkey Commissioners to institute proceedings against the Dublin Southern Tramways Company, to compel them to put the roads and footpaths in order. The matter stands adjourned.

Electric Traction in Austria and Hungary.—The horse tramways in the town of Temesvar are to be converted into electric lines. The Buda Pesth Electric Stadtbahn Company has just increased its capital for the purpose of extending its lines and increasing the plant.

Electric Tramway between Gorlitz and Treptow (Berlin).—This line was inspected and passed on the 15th of this month, and was opened the same day for traffic. The line is working very satisfactorily.

Stuttgart Tramways.—The total length of these lines is 24 km. The cars run on a five minutes headway; trail cars run on most of the lines. The average speed is 8 miles an hour; the gauge is 1 metre. The electric current for running the lines is furnished by the electric light works of Stuttgart, which were equipped by Schuckert & Co. The dynamos used in the power station are shunt-wound, and are so arranged that when run in parallel they feed a 3-wire system for lighting purposes, and when run in series they become available for traction purposes. There are 65 motor cars running at the present moment, each having a capacity of 16 inside, and 14 on the platform; each motor car is furnished with two single reduction motors. All the extensions on the Stuttgart tramways are going to be equipped on the overhead trolley system, which has met with universal approval from all the inhabitants of that city. An illustration in our possession shows a double bracket arm construction down one of the principal streets (Neckarstrasse), and is certainly a proof that, when properly constructed, trolley lines do not become eyesores. The tramway installation was erected by the Allgemeine Electricitats of Berlin.

The Big Tramway Scheme for London.—The big electric tramway scheme for London, which has been the subject of so much discussion in the Press of late, renders especially interesting a reference to the subject of electric traction in a recent Consular report on New Orleans. This city (says the *Financial Times*) has now one of the most perfect electric tramway systems in the world. It possesses 180 miles of tramways on which the cars are driven by electricity, and last year these conveyed 47,250,000 passengers, at an average fare of 2½d. per mile. The saving as compared with the old mule cars which formerly served the city is estimated at a quarter of a million sterling per annum. A speed of 12 miles an hour can be obtained with these cars, accidents to foot passengers are very infrequent, and the ordinary carriage traffic is actually relieved by the substitution of electric for mule traction on the trams. Curiously enough, our Consul predicts that it is only a question of time when this system will be adopted in London, and certainly the example of New Orleans will afford a good argument in favour of the promoters of the new scheme.

The Horseless Carriage Bill.—Lord Harris, in the House of Lords on 23rd ult., moved the second reading of the "Locomotives on Highways Bill." His speech contained special reference to electrical road vehicles. He said it would be possible, provided the law admitted it, that within a short time electrically propelled carriages would be seen running about the streets of London. He said that electrically propelled omnibuses would be as convenient in every respect as present conveyances. The maximum of two tons would, he was informed, entirely exclude electrically driven vehicles; but Mr. Chaplin was quite willing to consider any evidence as to what the maximum weight ought to be. Viscount Clifden, who agreed with the principle of the Bill, thought there was one point which needed alteration. As the Bill now stands, it seems that a horseless carriage may only propel itself, and not have any second conveyance connected behind. This provision may be very necessary for towns, but for farmers and others in the country districts this one point might prevent taking advantage of the Bill, whereas, were such provision modified in some way or other, these classes of the community might find the use of road locomotives exceedingly convenient.

The Waterloo to Baker Street Electric Railway.—The Unopposed Bill Committee of the House of Commons on Wednesday passed a Bill sanctioning an extension of the authorised Baker Street and Waterloo Railway, in order to effect a communication with the terminal station of the Manchester, Sheffield and Lincolnshire Railway Company's new line into London. The Bill also authorises the construction of this railway in three separate sections, each section having a distinct capital. An extension of time is also granted until March, 1901, within which to construct this railway.

TELEGRAPH AND TELEPHONE NOTES.

Presentation.—Mr. E. W. Newton, manager of the West Hartlepool district for the National Telephone Company, was on 22nd ult. presented with a dressing case, on the occasion of his removal to Newport, Mon.

Reduction of Telegraph Rates to India.—In a *Times* telegram from India we read the following:—"Attention has been drawn to the increase in the export of cotton from Bombay to Japan. This trade, which promises to assume immense proportions, is now greatly hampered by the high rate charged for telegraphic messages over the Eastern Extension cables. Merchants in Bombay are complaining strongly, as the rate is about seven rupees a word. It is quite as necessary that a reduction should be made in traffic rates to the further east as to Europe. The Eastern Extension Company may find landlines being used instead of cables, particularly if the project for connecting Kiangtung with Monglai by a wire carried across the Mekong Valley is taken up. The distance between the Burma and Tongking telegraph termini is only 220 miles. The existing landlines to China, through Bangkok and Bhamo, are liable to interruptions. The Kiangtung and Monglai route, lying throughout in British and French territory, could easily be maintained. Linking up would take a few weeks only, once the wire were placed at the present terminal stations." For some time past the heavy charges levied for telegrams between England and India have furnished a source of complaint from various quarters, and we understand that strong representations on this subject have been made by various Chambers of Commerce both in India and Great Britain, and doubtless the matter will come before the notice of the approaching Telegraph Conference. From the above telegram it would also appear that the same discontent exists with regard to the rates charged between India and the Further East. We learn from the report of the Eastern Extension Telegraph Company for the half-year ending December 31st, 1895, that the amount of gross receipts for this period is over £50,000 above the receipts for the corresponding period in 1894, an increase of about 20 per cent. There is, however, as yet no sign of a corresponding reduction in rates charged to the public, although the reserve fund of this company will stand at over £560,000, notwithstanding that it was depleted to the extent of £186,000 in the past half-year, by the payment of the balance of cost of the Singapore-Hong Kong cable. The revenue of the Indo-European Telegraph Company for 1895 also shows an increase, and the usual 10 per cent. is to be paid to the shareholders. This latter company, with a capital of £425,000, has a reserve fund of over £250,000, which, in the case of a submarine cable company, might be a reasonable figure, but it seems superfluous in the case of a concern which has only landlines to keep in order.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
" " (P.Q.) ...	June 24th, 1895 ...	...
Brest-Penzance (P.Q.) ...	.. ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Guernsey-Jersey	April 8th, 1896 ...	April 25th, 1896.
Ceara-Maranham	April 28th, 1896 ...	...
Landlines.		
Communication with Matagalpa Provinces of Leon and Chinandega	Feb. 26th, 1896 ...	...
Trans-Continental line beyond Mazol (Mashonaland)		
Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...
Saigon-Bangkok	April 21st, 1896 ...	April 22nd, 1896.
Siberian line near Khabarowka	April 24th, 1896 ...	April 25th, 1896.
Chabarowsk - Vladivostok (Siberia)	April 25th, 1896 ...	April 26th, 1896.
Radde-Khabarowka (Siberia)	April 27th, 1896 ..	April 27th, 1896.

Telegraphy and the Dongola Expedition.—From the following Reuter special service communication, dated the 26th inst, it appears that qualified telegraphists are somewhat scarce at Wady Halfa:—Lieutenant Manifold, R.E., has arrived from the front, having completed the laying of the telegraph to Akasheh. He chose the river route for the line, so that the Dervishes, if they should cut the railway, will not necessarily interrupt telegraphic communication. The greatest distance accomplished in one day was 15 miles. To prevent breakages, the heaviest wire, No. 8, was employed. At the start each camel carried one mile of wire. A telephone has been established. At present the telegraph is of a temporary character, improvised instruments being used; but these will be replaced in a few days by proper appliances, which have just arrived. Poles for the stretched line have already been erected as far as Ambigol. There is some difficulty in finding skilled operators.

Tunbridge Wells Telephone Service.—There is a movement among telephone users here to induce, or, perhaps—judging from a circular we have received—it is to try to compel the National Telephone Company to give a better service, and charge lower rates. The Tunbridge Wells Telephone Subscribers' Committee has been formed to endeavour to accomplish the desired result.

The Telegraph Service.—In the House of Commons, on Thursday, last week, Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether the sum of £7,600,000 had already been paid from postal revenue for interest on the £10,000,000 originally borrowed by the Government for the purchase of the telegraphs in 1870; and whether he could explain what measures were being taken to pay off the purchase money, and to relieve the telegraph service from the burden of the interest upon it. Mr. Hanbury said that no sums had been paid out of either postal or telegraph revenues for interest on the stock created for the purchase of the telegraphs. That stock had been treated as part of the general debt of the country, and the interest was included in the provision made for the debt charge. In the years 1870 and 1871, stock amounting to £67,600 was purchased by surplus balances of telegraph revenue and cancelled, but there had been no surplus since that date. No measures other than those applicable to the rest of the National Debt were being taken to pay off the telegraph debt.

Telegraphic Communication with the West Indies.—Mr. Chamberlain, replying to Mr. Tomlinson in the House of Commons last week, said he had received communications from the West Indian Colonies representing the importance of establishing improved telegraphic communication between this country and those Colonies for the purpose of Imperial defence, as well as for commercial purposes. He had no reason to think that there were insuperable constructive difficulties in effecting any such communication. Proposals on the subject were under consideration, and he hoped they might result in a cable being laid at no distant date.

The Pacific Cable Conference.—The Hon. Sir Mackenzie Bowell and Mr. Sandford Fleming will sail for England on 9th inst. to represent Canada at the Pacific Cable Conference. They will be accompanied by Sir Donald Smith, the new High Commissioner of Canada in London.

The City Telephone Service.—The National Telephone Company, on Tuesday, applied to the Commissioners of Sewers for permission to lay cables under certain City thoroughfares and roadways. As the company was not prepared to make any concession for the public benefit, the Commission decided to refuse the application.

The Evils of Telephone Competition.—The Cardiff Chamber of Commerce is of opinion that the existence of two competitive telephone systems there (the Post-Office and the National Company) is an evil needing to be immediately remedied, and the Chamber, after discussing the matter at length last week, resolved to petition the Postmaster-General and the Company on the matter.

The Telegraphs (Advances) Bill.—In the Commons, on 24th inst., on the report of the financial resolution appropriating £300,000 for this purpose, there was a discussion of no particular importance in connection with the real question, excepting the remarks of Mr. Hanbury, who said that no portion of this money would go to the National Telephone Company, which had already received about £450,000 out of the £1,000,000 provided in the former Bill. The rest of that sum had gone to purchase wires for the main trunk lines. The additional sum asked for was in order to complete the purchase of the wires. The Bill was then brought in by Mr. Hanbury and read a first time.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 1st. The municipal authorities of Prague are inviting tenders for the erection and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes. Tenders are to be directed to the Stadrath der Haupt, Stadt Prague, Prague, Austria, from whom full particulars may be obtained.

Belgium.—May 9th. Tenders are being invited by the Provincial Government authorities at Bruges, for the supply and installation of several electric water-level indicators. Tenders to be directed to the Gouvernement Provincial at Bruges.

Belgium.—May 27th. Tenders are being invited for the conversion into electric lines of about 20 kilometres of "Vicinal" steam railways in the Centre district. Tenders are to be sent to the Société Nationale des Chemins de Fer Vicinaux, 26, Rue de la Suence, Brussels, where full particulars may be had for the sum of 1 franc.

Bray.—May 18th. The Town Council invites tenders for a boiler, alternator, fuel economiser, engine, &c., for electric lighting. For further details see our "Official Notices."

Coventry.—May 12th. The Corporation invites tenders for the supply and erection of boilers and other plant for the boiler house, also steam engine, alternator, fittings, &c., for electric lighting. For further details, see our "Official Notices."

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

France.—May 5th. Tenders are being invited by the General Direction of the French Posts and Telegraphs for the supply of a multiple telephone switchboard for the telephone exchange at Nantes. Tenders to be addressed to the Direction Generale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Hammersmith.—May 27th. The Vestry invites tenders for cables, pipes, arc lamps and lamp posts, transformers, sub-stations, and overhead travelling cranes. Mr. A. H. Preece is the consulting engineer. For further details see our "Official Notices."

Hampstead.—As soon as specification and details have been prepared by the architect, tenders are to be invited for the proposed additional buildings at the central station.

Lima.—June 1st. The Municipal Council is inviting tenders for the establishment and working of the electric lighting in the squares and streets of the city, with power to work the private supply under a 20 years' contract. Particulars to be obtained at the Peruvian Legation, 13, Comeragh Road, West Kensington, W.

London, S.E.—May 6th. Tenders are invited for the provision and fixing of electric bells, telephones, fire alarms, &c., at the Brook Fever Hospital, Shooter's Hill, S.E., for the Metropolitan Asylums Board. Particulars can be obtained at the chief offices of the Board on and after 16th inst. upon depositing £5.

Roumania.—May 12th. The General Direction of the Roumanian Posts and Telegraphs in Bucharest are inviting tenders for the supply of 10 tons of galvanised steel wire, and 40 tons of galvanised iron wire.

CLOSED.

Bedford.—In response to the Electric Light Committee's recent invitation the following tenders for the supply and erection of one 240 B.H.P. double-acting compound engine, and one 150-unit alternator with stationary armature, were sent in.

Engine only:—

Messrs. W. H. Allen, Son & Co. (accepted)	£700
„ Sissons & Co.	790
„ Belliss & Co., Limited	1,050

Alternator only:—

Messrs. Siemens Bros. & Co., Limited	£1,250
„ Fowler & Co.	1,090
„ Crompton & Co., Limited	980
„ Mather & Platt, Limited	930
„ Manchester Edison-Swan Co., Limited	928
„ Electrical Construction Co., Limited	903
„ Johnson & Phillips	850
„ Easton, Anderson & Goolden, Limited (accepted)	654

Engine and alternator:—

Messrs. S. Z. de Ferranti	£2,350
„ Brush Electrical Engineering Company	2,253
„ D. Stewart & Co.	2,195

Constructing five sub-stations to specification:—

Mr. T. H. Coleman (accepted)	£235 0
„ G. E. Fathers	272 10
„ T. Laughton	295 0
„ J. P. White	325 0

The estimate of Messrs. Doulton & Co. for the supply of stoneware casing, at 2s. 3d. and 1s. 6½d. per yard respectively, was accepted.

Cardiff.—The following is a list of the tenders for electric light extensions, 1896, for the County Borough of Cardiff:—

PARTICULARS OF TENDERS.

Name.	Type of engine.	Type of alternator.	Kw.	Speed.	Price.
					£
Electrical Construction Co.	Peache	E.C.C.	250	350	2,493
Brush Company	Raworth	Mordey's	300	266	2,668
Crompton & Co.	Peache	Crompton & Brunton	300		2,770
Electrical Construction Co.	Pollitt & Wigzell	E.C.C.	300	127	2,970
Crompton & Co.	Willans	Crompton & Brunton	300		3,015
Crompton & Co.	Belliss	Crompton & Brunton	300		3,051
Ferranti & Co.	Ferranti's	Fly-wheel	300	300	3,250
Johnson & Phillips	Belliss	J. & P.	300	300	3,350
Siemens Bros.	Belliss	Siemens	300	300	3,360
Electrical Construction Co.	Belliss	E.C.C.	300	300	3,407
Ferranti & Co.	Belliss	Fly-wheel	300	350	3,500
Siemens Bros.	Willans	Siemens	300	267	3,740
Easton, Anderson & Goolden	Corliss	Patent	300	120	4,100

* Accepted.

Name.	Type of Boiler.	Price.
		£ s.
E. Danks, Birmingham	Dry-back marine	767 10*
J. Thompson, Wolverhampton	Economic	890 0
Fraser & Sons, London	Dry-back marine	974 0
G. Sinclair, Leith	Do. do.	990 0
Davey, Paxman & Co.	Economic	998 0
Crompton & Co.	Do.	1,028 0
Tinkers, Limited	Dry-back marine	1,060 0
Fleming & Fergusson	Clyde water-tube patent	1,079 0
Lindsay, Burnett & Co.	Dry-back marine	1,095 0
Hawkesley, Wild & Co.	Do. do.	1,100 0
Fleming & Fergusson	Do. do.	1,110 0
Babcock & Wilcox	Water-tube	1,100 0
Abbott & Co.	Dry-back marine	1,150 0
Electric Construction Company	Do. do.	1,155 0
Hornsby & Co.	Do. do.	1,400 0
John Brown & Co.	Scotch marine with patent draught, &c.	3,700 0

* Accepted

Germany.—The Prussian State Railway Authorities lately invited tenders for the supply and erection of the necessary plant and fittings required for the electric lighting of the railway stations at Elberfeld and Barmen. The contract comprises four steam engines, four dynamos, and 174 arc lamps, with the necessary mains and accessories. Thirteen firms tendered, the Helios Company of Ehrenfeld, Cologne, quoting the lowest for the Elberfeld installation (£4,346), while for the Barmen plant the lowest tender was that of Messrs. Lahmeyer & Co., of Frankfort (£3,060). The highest tender in each case was, respectively, £6,234 and £4,496.

Islington.—The list of tenders sent in for wiring and fitting, for electric lighting the Northern Polytechnic Institute, is interesting. It will be observed that the highest tender sent in for the work is nearly five times that of the lowest and accepted estimate. The highest tenderer is evidently not used to tendering for such work.

Messrs. Russell & Lennard (accepted)	£219
„ Wenham & Waters	245
„ Vaughan & Brown	266
„ Faraday & Son	340
„ Crompton & Co., Limited	407
„ Strode & Co.	419
Mr. A. Fearnhead	1,027

London.—For the electric lighting of the church of St. Mildred, Bread Street and St. Margaret Moses, the tender of the Tayler Smith Electric Company, Limited, amounting to £141, has been accepted.

CITY NOTES.

French Thomson-Houston Company.

As will doubtless be remembered, the Compagnie Francaise pour l'Exploitation des Procédés Thomson-Houston was formed in April, 1893, for the working of this system of electric lighting and traction, and for taking part in other electrical enterprises. The capital of the company, which was originally fixed at 1,000,000 francs, was increased to 5,000,000 francs in April, 1894. The result of this augmentation in the capital was to enable the company to free itself from its obligations to the American Thomson-Houston Company, by the transfer to the latter of 4,000 shares, and to form a special company, with a capital of 1,200,000 francs, for the acquisition of the Postel-Vinay Engineering Works, which henceforth served as the company's works in Paris. Thus equipped for business, the company has been able to introduce the Thomson-Houston system in, among other towns, Bordeaux, Lyons, Roubaix-Torcoing, Havre, and at Belgrade. Besides this, the company has taken an interest in the Versailles Electric Tramway Company, and the Bordeaux-Pessac Company, and has obtained concessions for the establishment of tramways in Algiers and Mustapha. Apart from this, financial interest has been taken in the foundation of an electrical company at Brussels and the Rouen tramways, whilst a contract has been concluded with the Compagnie des Tramways de Paris et du Departement de la Seine, for the construction of two lines leading from the Place de la Republique to Pantin and Aubervilliers. The carrying out of these operations has necessitated the issue of 10,000,000 francs in bonds, which were subscribed in a few days. The result of the company's operations is shown by the fact that the dividend of 5 per cent. in 1893 and 1894 has been increased to 8 per cent. in 1895, with the sum of 300,000 francs being carried to reserve.

Some Accounts from Hampstead.

To judge by the local prints, the agitation for accounts of the electric lighting works has resulted in some being prepared up to the end of March. The Electric Lighting Committee have further reported that they found that the efficiency of the transformers and mains had risen to 76·3 per cent. for the quarter ended March 31st; that during March 20 applications for current were received, and 15 customers connected, with an equivalent of 1,288 8 candle-power lamps; that the number of applications received this year to the end of March was 63, and 58 were connected, with 3,538 lamps, and that the total number of applications to that date was 324, 305 of which were connected, with 22,945 lamps, as against 261 applicants and 247 connected, with 19,407 lamps, at the end of December; and, further, that they found that the works cost of the central station for the three months ended March 31st was £1,231 9s. and that the total kilowatt hours generated were 121,656, being equal to 2·29d. per unit. The report was approved.

The Oxford Electric Company, Limited.

With reference to the issue of 1,414 ordinary shares of £5 each, which was recently alluded to in our "City" columns, the secretary of the company informs us that they were very much over applied for, and that letters of allotment and regret in respect of them have been posted. The latest price at which they have changed hands is £5 15s., or at a premium of 15s.

The Elmore's German and Austro-Hungarian Metal Company, Limited.

If we were shareholders in the Elmore's German and Austro-Hungarian Company, we cannot say that the directors' report, an extract of which was published in last week's Review, or the remarks of the chairman at the meeting held on Monday last, would afford us much comfort. It is all very well to say that lack of working capital is the only obstacle in the way of the company's progress, no doubt it is, but the shareholders who have contributed £156,000, cannot look with equanimity upon the proposal to raise more money, which, of course, will take precedence to theirs. Perhaps some ready money would save the company, but it is almost impossible for it to achieve solid commercial success with the present constitution of the capital. Already there is a debenture stock of £25,000, which bears interest at the rate of 8 per cent., and constitutes a first charge upon all the assets of the company. And what is more, the whole of this stock has to be redeemed on or before July 1st, 1898, at 105 per cent. It is only fair to say that as regards manufacture and sale of copper the company has made remarkable progress, and Mr. Preschlin, the manager of the works, exhibited at the meeting some interesting diagrams, the most important of which showed that in 1893 the wages represented 60 per cent. of the sales, in 1894 30·3 per cent., in 1895 14·9 per cent., and in 1896 they are estimated not to be more than 11 per cent.

The Bradford Accounts.

Mr. Alfred Gibbings, the Borough Electrical Engineer at Bradford, is not permitting the Corporation works to fall behind the excellent figures that characterised Mr. Sydney Baynes's control. The net revenue from the year's working amounts to £7,667, of which £2,293 is placed to the sinking fund account, £500 to depreciation of capital, and £1,832 provides interest on mortgage. It is interesting to observe that the Corporation have borrowed £67,876, and repaid £10,550.

The following table gives the cost per unit:—

	1893.	1894.	1895.
Total capital invested	—	£64,716	£71,457
Number of units sold	—	—	673,699
Number of lamps connected ...	—	—	—
Revenue from sale of current...	—	—	£13,419
Total cost of working	—	—	£5,914
Net revenue	—	—	£7,668
Average price obtained per unit	—	—	4·78d.

Cost of production.	£	s.	d.		Per unit.
Coal	1,580	0	0		·56d.
Oil, waste, water and engine room stores	465	0	0		·16d.
Salaries and wages at generating station	1,461	0	0		·52d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	802	0	0	Works' cost 1·53d.	·29d.
Rates and taxes	780	0	0		·28d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	827	0	0		·29d.
Depreciation of buildings and plant account	500	0	0		·18d.
Sinking fund account	2,293	0	0		·81d.
Total	£8,708	0	0		3·10d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	13,419	0	0	—
Meter rents	349	0	0	4·78d.
Sale of lamps	—			—
Total	£13,768	0	0	4·78d.

Total cost per unit	2·1d.
Works' cost per unit	1·53d.

Losses due to Street Lighting.

The loss on the public lighting at Kingston, to which we refer below in speaking of the Kingston accounts, reminds us that it is by no means an isolated instance. One is coming constantly across cases where current is being sold for lighting purposes at less sums than it costs to manufacture. There are occasions when a municipality would be justified in lighting its streets at a loss, providing the profits on the private lighting were sufficient to cover it. The actual cost of arc lighting, however, must be very much misunderstood. At Hastings, the company entered into an agreement with the Corporation to light certain streets, and the transaction has resulted in a loss to the company. Such results are not gratifying, and there is apparent need of some improved methods in estimating.

The Kingston-upon-Thames Corporation Accounts.

The second annual report of Mr. J. E. Edgcome, the Borough Electrical Engineer at Kingston-upon-Thames, shows that the municipal undertaking is making some progress. One would like to see electric lighting more common than it is in Kingston, especially when the local authorities have had the courage to embark upon a public lighting scheme. There is no doubt, however, that in the early stages of electric lighting at Kingston many of the residents were prejudiced against it, perhaps the occasional trouble with the street lighting helped to foster this spirit, but still we believe the inhabitants are gradually overcoming their antipathy, and it is hoped that it will take a practical shape. The following extracts from Mr. Edgcome's report show the additions that have been made to the plant during the past year:—

"Since the last report a Reeves patent filter has been fitted in the boiler house, for the purpose of extracting the oil from the condensed water before returning it to the boilers. A Maignen water softening plant has been erected near the boiler house for the purpose of softening and purifying the raw feed water taken from the river, in order to avoid any future trouble from scale forming in the boilers. A second coal shoot has been laid down behind the works, so that a stock of coal of 100 tons can be kept in hand in case of strikes or other unforeseen circumstances interfering with the delivery of fuel. The arrangements for launch charging will be completed within a month, and a supply of current for electric launches will be available from the works during the boating season. A number of cable extensions have been carried out, the mains having been laid for the purpose of connecting fresh consumers, to Kingston Hill, Manorgate Road, Cambridge Road, Fassett Road, Grove Crescent, and Lingfield Avenue. The two sub-stations in London Street and the Horsefair have been completed and equipped with transformers and high and low tension switch and fuse gear, and connected to the low tension mains. An extra 25-kwt. transformer, with switch and fuse gear, has been placed in the sub-station under the Town Hall. Further low tension mains have been laid in Thames Street, so that that thoroughfare has now distributing mains equal to ·6 square inch, and capable of supplying current to 1,800 8-candle-power lamps. A service main has been laid to the sewage works, which are now lighted electrically throughout. The labouring class dwellings built by the Corporation in Pheasant Lane are also lighted electrically. The number of consumers has increased from 77 at the end of 1894 to 99 on December 31st, 1895, on which date the number of lamps installed was equal to 4,800 of 8-candle-power."

We give the following figures just as they stand in Mr. Edgcome's statement for the year:—

Electricity Supplied.

Quarter ending	Units.	Electricity.	Meter rents.
March 31st, 1895 ...	18,962	£468 4 1	£14 9 0
June 30th " ...	9,410½	232 16 10	15 7 6
Sept. 30th " ...	10,679½	265 12 3	15 15 0
Dec. 31st " ...	28,394½	650 17 11	16 8 6
	67,446½	£1,617 11 1	£62 0 0

Units Supplied.

The number of units supplied from January 1st to December 31st, 1895, was:—

To Private consumers	67,446
" Public arc lamps	66,638
Total units sold	134,084

Total Receipts for Current Supplied.

	£	s.	d.
From private consumers	1,617	11	1
Charged for arc lamps, £20 per lamp per annum	720	0	0
Total electricity receipts ...	£2,337	11	1

Revenue per unit = 4·184d.

Revenue Summary for 1894 and 1895.

	1894. £	s.	d.	1895. £	s.	d.
Total works cost...	2,573	3	4	2,704	3	1
" receipts	1,985	19	7	2,441	19	3
Deficit on works	587	3	9	262	3	10
Repayment of principal and interest...	711	14	10	1,120	6	0
Total deficit on year ...	£1,298	18	7	£1,382	9	10

It will be noted that half the current supplied is used for the street lighting, and although the sum of £20 per annum is charged for each street lamp, the rate per unit is 2½d., which is about half

what it costs to produce. As the average price obtained per unit from private lighting is slightly over 5½d., it is only fair to assume that a good deal of the deficit on the year's work is due to the street lighting. When the loss on the street lighting is, of course, fairly recognised, one could not possibly raise any objection; but if it is not, it provides the opponents of electric lighting an occasional opportunity of pointing out the loss on municipal works. Reverting, however, to the charge per unit for arc lamps, 2½d. is, in our opinion, too small; at the same time one does not like the idea of a street lamp, the cost of which exceeds £20 per annum. Arc lighting has to be more subdivided before we can arrive at a really satisfactory system of street lighting by electricity. The total deficit for the year is increased by £83 11s. 3d., but that includes an extra amount of £408 11s. 2d. for repayment of principal and interest, so that the loss on the works has been reduced fron £587 3s. 9d. to £262 3s. 10d.

The following table gives the cost per unit:—

	1893.	1894.	1895.
Total capital invested ...	—	—	—
Number of units sold	—	—	134,084
Number of lamps connected ...	—	—	—
Arc lamps	—	—	—
Revenue from sale of current...	—	—	£2,338
Net revenue	—	—	—
Average price obtained per unit	—	—	4·19d.

Cost of production.	£	s.	d.	Per unit.
Coal	1,100	0	0	1·97d.
Oil, waste, water, and engine room stores	149	0	0	·27d.
Salaries and wages at generating station	597	0	0	1·07d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	422	0	0	·75d. (Works' cost 4·06d.)
Rates and taxes	108	0	0	·19d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	293	0	0	·52d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£2,669	0	0	4·77d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	2,338	0	0	4·19d.
Meter rents	62	0	0	—
Sundry sales	42	0	0	—
Total	£2,442	0	0	4·19d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·77d.; works' cost, 4·06d.

Elmore's German and Austro-Hungarian Metal Company, Limited.

Mr. John MacFarlan presided at a meeting of this company, held on Monday, and said the accounts now presented show a satisfactory state of affairs. It will be seen, on comparing the balance-sheet of this year with that of 1894, that the whole of the second debenture stock, amounting to £25,980 0s. 9d., has been redeemed. In addition to this, no less than 12,019 ordinary shares (£24,038) have been either cancelled or forfeited, so that while the shares and debentures have been reduced by no less a sum than £50,018, existing shareholders (preference and ordinary) have been put to no expense, and instead of taking a third and fourth place, they now take second and third. The whole of the deficit, both of the Metall Company, which amounted to nearly £20,000, and of this company, which also was a large sum, has now been written off, and we start the year 1896 with a clean balance-sheet, with the exception of the sum of £1,575 9s. 5d. brought forward by the Metall Company. The arrangements to carry this change into effect were made with great care, and caused a considerable amount of trouble, but as the sum of £40,631 0s. 7d. standing in the company's debit has been written off, and will not appear in the accounts again, and, in addition, the patent account has been reduced by the sum of £1,441 7s. 8d., the result is most satisfactory. Turning now to the balance-sheet of the Metall Company, you will see that the capital has been reduced to £30,000. This has been done to meet the German law regarding companies, which requires that if a certain loss is made the company must call a meeting and reduce its capital by an amount equal to that lost. And if the company does not comply with the Act, the Government steps in and reduces the capital itself. The depreciation shown in the accounts has been as follows:—In 1893, £3,300 0s. 10d.; 1894, £3,198 4s. 7d.; 1895, £2,554 8s.—or in all £9,052 13s. 5d.—and is, in our opinion, excessive. In the first place, the company is young, and the depreciation should have been spread over a great number of years; and, in addition, we claim that the new patents taken out since we began to work have increased the life of the whole of the patents. We are still increasing our plant, no less a sum than £2,511 16s. 3d. having been spent last year. The amount was judiciously expended, and we have full value to show for it, not only in new plant, but in considerable alterations to the old plant. Referring now to the trading account, this shows a great improvement upon the year 1894. The sales are more than double, while the amount spent on manufacturing purchases and wages, after deducting copper, is not very much larger than in 1894, and it must be remembered that the stock-in-trade in hand on December 31st is £2,194 3s. 6d. more than it was on December 31st in the previous year. The price of copper on December 31st was £41 5s. per ton, as against an average price of £43 per ton for the whole year. Had the price not dropped so suddenly on December 31st, the value of our copper stock would have been much higher. The improvement in sales, though considerable, is not so great as we expected, but we had great difficulties to meet which could not be foreseen. First, in the early part of the year we had a very hard winter, such as has not been known for years; the river was frozen and the ice blocked the turbines, and so limited the water supply. After that difficulty had disappeared, a workman one day, during the dinner hour, started the big draw-bench, and, unfortunately, could not stop it, and the consequence was that the carriage got caught in the main driving wheel, and caused damage that took us over a month to repair. After that we had the drought. We had purchased an engine from Messrs. Willans & Robinson which was calculated to be able to cope with any want of water that we were likely to encounter, but this drought was the worst known for many years, and we were short of water for nearly three months. But for this long period of comparative inactivity, the sales would have been much higher, and at the same time the manufacturing purchases would have been even lower. It is only when we are forced to burn coal that we realise the value of our water-power. It should be remembered that the difficulty in working this business is that a large amount of working capital is required. In other industries, as a rule, the raw material is cheap, but in our business the raw material is very expensive, and while we have to purchase for cash, we are compelled to sell at three months' credit, according to the conditions of the trade, and we have to wait very often four months for our money. You will see by the balance-sheet that we have no less a sum than £11,478 9s. 5d. locked up in copper, stores, and with sundry debtors. We must always look forward to a considerable lock-up of capital under this head, and as the business increases so also will the lock-up increase. The following is a *resumé* of the amount of work done:—1893, £3,194 3s. 4d.; 1894, £8,130 10s. 10d.; 1895, £17,052 12s. 3d.; and it shows that, although the progress has not been so great as one could have wished, still, substantial advance has been made, and it is not too much to say that we have proved to the satisfaction of the trade in Germany that the Elmore products are superior in every way to the goods produced by the old process. That is demonstrated by the number of repeat orders we have received—as many as 110 having been received from one firm—and also by the fact that we have again secured the Imperial Railway's contract for the present year, and also contract with some of the most important manufacturing firms in Germany. We have supplied the Government with a fair amount of goods during the past year, apparently to their satisfaction, as they have not made a single complaint. We have developed to a very considerable extent the small tube trade, and we can now produce tubes from one-eighth of an inch up to 7 feet in diameter. The number of orders that we have in hand precludes us from giving an early date for delivery, and in many cases we are compelled to refuse good paying work. All this is detrimental to the interests of the company, because we are likely to turn away good customers, besides losing the profit that we should make. As to the present year. Up to the 19th inst. (16 weeks) the sales have amounted to 59¾ tons, of the value of £5,648, as compared with 40¾ tons, of the value of £3,706 last year. We admit that, from a shareholder's point of view, progress has been slow, and disappointments grievous; but these are always encountered in the working out of any new invention, notably, I am informed, they were met with in the case of the Bessemer steel process. After referring to what the board had done for the company, the chairman said, we have also, as directors, helped the company financially in other ways. But, gentlemen, there is a limit to our endurance, and it has been reached. We do not set a high value on our services, but we say that we cannot much longer bear the worry and risk and responsibility of our present position. The business is essentially one to be conducted on a large scale, if it is to have the full measure of success of which it is capable, because the fixed charges for management and direction do not increase with the increase of sales. This was a fact early recognised and acted on by the manager of the French Elmore Company, and now that every technical difficulty in working has been overcome, it is necessary for this company, if it is to succeed, to work on the same lines. We consider that you, on your side, cannot ask your directors or individual shareholders to continue to bear the heavy responsibility that now lies upon them. We claim that past years of faithful service and devotion to your interests entitle us to ask you to relieve us of this strain, and put us in possession of the sum required to carry out the extensions we consider to be necessary. We estimate the amount at £25,000. There is another point which is of very great importance to us just now. If you will refer to the balance-sheet of the Austrian Company, you will see that we have to pay £4,200; balance of the final instalment on the property. Out of the £25,000 we propose to raise, this is our first expenditure. The vendor is giving the company as much time as possible, but he is in the same position as ourselves, and requires the amount for working capital in his own business. I will only say that the future is in your hands. You have the power to make this

an extremely flourishing concern, or to allow it to drag on, working from hand to mouth without the means of extending, and so waste many valuable years, during which time dividends could have been earned. Negotiations have been begun for the working of our Austro-Hungarian patents, and from the last information we have, the result promises to be satisfactory. I now have pleasure in moving the adoption of the report and accounts.

Mr. JOHN HEAL seconded the resolution.

Mr. PRESCHLIN, the manager, referred to three tables which he had prepared, and which were exhibited on the wall. The first, he said, represented the amount of sales in the years 1893, 1894, 1895, and from January 1st to April 21st, 1896. The ratio of increase in these years was about as 1 : 2 : 4 : 8, the figures being—14,605m in 1893, 22,252m in 1994, 62,230m in 1895, and 114,650m in 1896. The reason their output figures had never reached their expectations, was especially because of the deficiency of the original plant, and also difficulties of an electro-chemical nature. Their output had now reached 7·4 tons per week. The theoretical capacity of the plant was 10 tons per week, but some of the tanks were always being stopped for the purpose of being emptied and refilled, as well as for cleaning and repairs. They would, however, be able to bring the effective output up to 8½ tons, but that would be the maximum. Table 2 showed the ratio between the wages and salaries and the sales. Whereas the sales showed the increase already mentioned, the amount of salaries and wages together remained almost the same. In 1893 the wages represented 60 per cent. of the sales; in 1894, 30·3 per cent.; in 1895, 14·9 per cent.; and in 1896 it would not be more than 11 per cent. The ratio of the sales and wages could, with an increased output, be still further improved. Owing to the small production and the alterations in the plant, trading results had not been favourable, but if they compared the results of the past year to those of 1893 and 1894, they would see that the company had made a good step forward, for a profit of £3,654 was shown, against a loss of £2,103 in 1893 and £8 16s. in 1894. The average selling price during 1894 was 11½d. per lb., whereas in 1895 it was only 10½d. per lb. This was mainly caused by a number of Government contracts being undertaken, with somewhat reduced prices. But since they had been able to produce also small tubes, the average selling price had been raised again to 11d. per pound, and this was further increasing. They had had to refuse orders, and if the present small plant were not extended, they would soon be very awkwardly placed, and run the risk of losing many a good and valuable customer.

The report was then adopted.

Hastings and St. Leonard's Electric Lighting Company, Limited.

THE annual meeting of the company was held at the Queen's Hotel, Hastings, on Friday.

The CHAIRMAN (Mr. F. A. Langham), in moving the adoption of the report, of which a summary appeared in last week's ELECTRICAL REVIEW, expressed regret at its character, but considered there were good prospects before the company. During the year, the number of lights running was 8,199, an increase over the previous year of 988. The law expenses were £137 more than last year; £840 had been lost on the sale of the installation fittings, and the bad debts were £355 more than last year. Taking all these items into account, the net increase of income amounted to £237. With the extraordinary items he had mentioned, the shareholders would see that the income had increased by £1,302, and the expenditure by £600. They could thus see that they could not pay a respectable dividend. He was not sure that the new system of the sale of the current benefited either the company or the consumers. Large consumers might derive benefit, but the more electricity they used the cheaper it got. He was sorry that the public lighting had been a great burden to the company, and had ended in an absolute loss. They had fulfilled their contract to light the sea front at a very low sum, and the loss on this account, coupled with the expenses necessary for lighting, meant quite sufficient to pay a dividend. Until they could get rid of the contract, or get better terms, the company would not be in a flourishing condition. The directors were considering what price they could charge the Corporation for the light. If they did not wish to continue, the Corporation was bound to buy the fittings and wires at a valuation, so that the shareholders would get some of their money back. They had enough private incandescent lighting to supply to keep them busy.

Mr. H. G. SHORTER, in seconding the motion for the adoption of the report, said he thought the latter gave them hope for better times.

Dr. B. H. ALLEN said he was disappointed with the report, as he had fully expected a dividend of 2½, if not 5 per cent. The company's position was due to installation losses, increase of the capital by £1,900 in 1894, unprofitable lighting of the sea front, and excess in the cost of manufacture. As to the front he thought they should give up the contract, if it could not be renewed at a better price. It seemed that they were not economical enough. They should not pay £350 in salaries and £200 in directors' fees.

The report was adopted, and Messrs. F. J. Parsons, the retiring directors, and Messrs. Hart Brothers, Tibbetts & Co., the retiring auditors, were re-elected. The proceedings closed with a vote of thanks to the chairman.

Indo-European Telegraph Company, Limited.

AT the meeting of this company, held on Wednesday, at Winchester House, J. H. Tritton, Esq., presided.

The CHAIRMAN moved the adoption of the report and accounts, and the declaration of a dividend for the half-year ended December 31st, 1895, of 17s. 6d. per share, making 6 per cent. for the year, and a bonus of 20s., making in all 10 per cent. for the year. He said the year had been a blank so far as unusual or exciting variations or occurrences were concerned. They had earned a good dividend quietly. The revenue was satisfactory. There was an increase in the receipts for the year 1895, as compared with 1894, of £4,616. That was due to the trans-Indian business which was caused by the discoveries of gold in Australia, and the consequent extra telegraphic communication. Regarding the use of telegraph codes, he said that the code tariff over this company's wires with India took rank among the lowest tariff in the world, and for each 100 miles of line is so very much below the charge made, for instance, over the Post Office wires in this country, as to be beyond all reasonable comparison. That statement could be proved by figures. The expenses of 1895 were £67,820, or between £2,000 and £3,000 over 1894. There would be held in June at Buda Pesth a conference of delegates from all the States, and at this conference would be discussed the rules, regulations, &c., in connection with international tariffs.

Major-General TREMENHEERE seconded the resolution, which was adopted, and after the retiring directors and auditors had been re-elected, a vote of thanks to the board and staff concluded the proceedings.

The Eastern Extension, Australasia and China Telegraph Company, Limited.

THE MARQUESS OF TWEEDALE presided at the ordinary general meeting of this company, held at Winchester House, on Wednesday. In his opening remarks he referred to the illness of Sir John Pender; in going through the report and accounts he dwelt on the fact that the gross receipts for the half-year showed an increase of over £50,000, while the receipts for the whole year (£575,722) showed an increase of £66,719. The working expenses had increased by £9,263. The balance, after paying dividend, was £129,329, had been carried to the reserve fund, which, after debiting cost of alteration of Singapore-Hong Kong cable, and cable renewals, stood at £561,546. After referring to the necessity of a large reserve fund, the chairman said they had not been forgetful of the interest of the telegraphing public, and had decided to revise the local tariffs from July 1st. This would result in a considerable loss, not less than £40,000 per annum; they could, however, meet it with equanimity, for they looked to recoup themselves from the increase in traffic that would take place. They had been invited to the International Telegraph Conference to be held in June, when it might be impressed upon them that they should make still further reductions. Such demands would receive the fullest consideration compatible with the interests of the company. Referring to the proposal to connect Canada with Australia by means of a cable touching only British possessions, many of the statements put forward in support of the scheme appeared to be wanting in precision, and even in accuracy. He was glad to say that an Imperial Commission would be held very shortly, when the subject would be considered in a business like manner. His own impressions were that the difficulties, physical and financial, would be found greater than was generally believed. At any rate, the board would do all in their power to protect the interests of the shareholders.

The report was then adopted.

The Western and Brazilian Telegraph Company, Limited.—The directors, subject to final audit, have decided, after placing £3,000 to the reserve fund, and £7,952 to the debenture redemption fund, to recommend, at the forthcoming meeting of shareholders, the payment of 5s. 3d. per share, free of income-tax, making, with the interim dividend paid in November last, a total distribution of £3 per cent. for the 12 months ended December 31st, 1895, the same as paid for 1894. This will give 5s. 3d. to the ordinary, 3s. 9d. to the preferred ordinary, and 1s. 6d. to the deferred ordinary shareholders.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the Official List:—Crompton & Company, Limited—£82,850 5 per cent. first mortgage registered debentures. National Telephone Company, Limited—Further issue of £229,471 3½ per cent. debenture stock.

Continental Edison Company, Limited.—At the annual meeting on April 22nd of the Compagnie Continentale Edison, the report of the directors was adopted, recommending the distribution for 1895 of a dividend at the rate of 25 francs per share. This figure compares more favourably with that for the previous year, when a distribution at the rate of 20 francs per share was made.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 26th, 1896, were £899; week ending April 28th, 1895, £900; decrease, £11; total receipts for half-year, 1896, £16,149; corresponding period, 1895, £16,119; increase, £30.

The Liverpool Overhead Railway Company. The receipts for the week ending April 26th, 1896, amounted to £1,168; corresponding week last year, £1,121; increase, £47.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 24th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,648.

NOTES.

A Word to Publishers.—The electrical man has hardly time to sneeze nowadays, so busy is he running his plant, or carrying out extensions. Therefore, ten chances to one he will not be able to read cumbersome books, however important the subject, and be his desire never so ardent. The tendency in electrical matters is towards conciseness, and it must be so in publications in particular, to meet the requirements of such a man as the electrical engineer. As well as conciseness, this all-important being needs compactness, and this is a point which publishers of technical works should take to heart. The smaller the size of an electrical book, the more use it will be, and consequently the larger its sale. What is wanted is not a book the size of a family bible, but one in size of page and cover similar to a pocket-book, so that when these odd moments occur, the engineer can take it from his pocket, and digest a little at a time and think it over as he goes about, or when his attention may not be specially upon his work. Publishers should make a note of this point. It is worth considering.

Accidents Due to Gas.—At Clive Road, Holloway, a gas explosion occurred on 23rd ult., the gentleman occupier being so seriously injured by fire and shock as to necessitate his removal to a hospital.

A few days ago a serious gas explosion occurred at the residence of Dr. Hall, of Rowntree, Monaghan, considerable damage being done to the house, and two men narrowly escaping with their lives.

Another death occurred on 22nd ult. as the result of the explosion at the Huddersfield Gas Works.

On Saturday last a fire occurred at Cliftonville, Belfast, a gas explosion being the cause.

Two Hampstead servants were found dead in bed last Saturday morning, escaping gas being the cause of death.

Turkish H_2 O.—The ignorance of the Turk will doubtless be spoken of by generations long after Turkey as a European Power has ceased to exist, or at any rate, long after the present Sultan has ended his heartless and disastrous reign. An amusing instance of the wonderful extent of this ignorance is cited by a trans-Atlantic exchange. The censors of Turkey prohibit the importation of all educational books, this state of affairs being brought about by the discovery in one book of the formula H_2 O, which the wise men of the court interpreted to mean: "Hamid II. is naught—a cipher—a nobody."

Lightning and Trees.—The likes and dislikes of lightning respecting trees have formed the subject of some recent investigations instituted by Dr. Carl Müller, and published in *Himmel und Erde*, statistics which were gathered showing that in 11 years lightning struck 56 oaks, three or four pines, 20 firs, but not a single beech tree, although seven-tenths of the trees were beech. Therefore, remarks a contemporary, it would appear that in a storm it is safer under a beech tree than under any other.

Electrical Engineering in Italy.—A 30-years' concession has been secured by Messrs. Schuckert & Co., of Nuremburg, for the utilisation of the water-power of the River Brembo, near Clenezzo and Sedrina, where plant is to be put down for the generation of electrical energy for distribution for power purposes at Bergamo, Alzano, Maggione, Clenezzo and Seriate.

Elimination of Surface Leakage.—A method of eliminating surface leakage when testing for insulation, is described by Mr. A. Rowell in a recent number of *Electric Power*. We may remark that this method is precisely similar to that devised by Mr. A. Price, and described in the No. of the REVIEW for December 6th, 1895.

Search Light in Gunnery Practice.—We learn that an electrical plant has been laid down near Lydd Camp, Romney Marsh, for the purpose of working the search light. This will be used for heavy gun firing practice at various objects at night time.

Obituary.—The death is announced of Mr. H. J. Vose, M.I.E.E., of Cardiff, Superintending Engineer of the Post Office Telegraphs for the South Wales District. Mr. Vose passed practically the whole of his official career in the Engineering Department of the Telegraphs. He joined the staff of the late Mr. Edward Graves in 1871. Mr. Graves was then Divisional Engineer of the old North-Western District with head-quarters at Birmingham. On Mr. Graves's promotion to the position of Engineer in-chief in 1878, Mr. Vose followed him to London, and acted as his confidential assistant, with a short break, until his death in November, 1892. Mr. Vose was then appointed, on the recommendation of the present engineer-in-chief, Mr. W. H. Preece, to the superintending engineership at Cardiff, in succession to Mr. J. Gavey, who removed to London on promotion as principal technical officer on the head office staff. He had been in failing health for a considerable time past, and for at least 12 months his condition had been such as to cause much anxiety to his friends and colleagues. It was hoped that his comparative youth would eventually enable him to throw off the disorder, and recent reports of his condition favoured this view, but on Sunday last he suffered a severe relapse, and passed peacefully away on Tuesday morning. Mr. Vose was in his forty-sixth year, and he leaves a widow and three children to mourn his loss.

The Eck Arc Lamp.—This type of arc lamp, which was first brought before the public at the Lyons Exhibition in 1894, is now receiving a practical demonstration in Paris. At the moment, no less than 108 Eck arc lamps are being used for the lighting of the Avenue de la Republique. The current is furnished from the new power station of the Paris-Romainville Tramway, which is shortly to be set in operation, the lamps being arranged nine in series. The mechanism of the lamp is claimed to be exceedingly simple, and in the event of one lamp becoming cut out of circuit, an automatic resistance is immediately thrown in, and takes the place of the lamp.

Wenström Alternating Current Motors.—We have recently had the opportunity of inspecting the Wenström alternating motors running from the City of London Company's mains at the premises of Messrs. Fuller & Co., 28, Bush Lane, who are the sole agents. These motors will probably give a fresh impetus to the users of motive power from the mains of alternating current supply companies, for the utmost care appears to have been bestowed on the minutest details, and the efficiency is said to be higher than that of other machines.

Appointments.—We learn that the Postmaster-General has made the following appointments:—Mr. John Cameron Lamb, C.B., C.M.G., to be Third Secretary to the Post Office, in succession to Mr. Herbert Joyce, C.B., retired. Mr. Lamb will remain in charge of the Telegraph Branch. Mr. Lewin Hill to be Acting Joint Third Secretary to the Post Office. Mr. Edward Yeld to be Assistant Secretary to the Post Office.

Lectures.—At the University College, Liverpool, on 23rd ult., Mr. Hay commenced a series of lectures on "The Theory of Alternating Currents."

At Cardiff, on 22nd ult., Mr. W. J. Leyshon lectured on "The Romance of Electricity."

The Institution of Electrical Engineers.—By the kind permission of Mr. D'Alton, a party of students of the Institution will visit the London Electric Supply Corporation's Station at Stowage Wharf, Deptford, on Saturday, May 9th.

Cantor Lectures.—Mr. James Swinburne's second Cantor lecture on "Applied Electro-Chemistry," will be delivered at the Society of Arts next Monday, at 8 p.m. He will deal with "Caustic Soda and Bleaching Powder—Copper Refining—Zinc." The first of the series was delivered last Monday.

Organ Blowing by Electricity.—We understand that the Hope-Jones Company are at present fitting up a new 220-volt motor at the Mitchell Hall, Aberdeen, in the place of the 110-volt machine, for blowing the organ.

Colouring Matters by Electrolysis.—We have already had occasion to notice that some of the colouring matters hitherto only produced by strictly chemical processes can also be manufactured by electrolytic processes, and it seems extremely likely that the near future will see a very large number of such substances being made by electro-chemical means. Towards the end of last year it was discovered that certain orange colouring matters can be obtained by electricity, and now we understand that they are being made on a commercial scale at Basle, in Switzerland. It seems that by reducing the yellow alkaline condensation products of p-nitrotoluene sulphonic acid in an alkaline solution by means of the electric current, the yellow colouring matters are converted into orange dyestuffs. A mercury cathode is preferably employed, as the production then proceeds at a lower temperature. The best strength of current is 5—15 amperes per square decimetre of cathode area. About 10 kilos. of p-nitrotoluene sodium sulphonate are condensed in the usual manner in an aqueous solution with 30 kilos. of soda lye of 30° B. After dilution with 70 litres of water, the whole is reduced at 45° C. in an electrolytic cell with a mercury cathode until a sample is spotted on paper which shows a red spot free from yellow. The solution is then neutralised and the dyestuff salted out. After filtering and drying, it forms a dark brown powder easily soluble in water, with a yellowish-red colour, and in concentrated sulphuric acid with a dark violet-blue colour. It dyes unmordanted cotton orange from a neutral or alkaline bath, fast to air, chlorine, and acids. If this new process stands the test of time, and succeeds in producing dyes which possess as good qualites as the same substances manufactured by chemical processes, and at the same time possess commercial advantages, we may anticipate that a new and important field will be opened up which may be usefully exploited by those who complain that the electrical profession is overcrowded.

Photographing Projectiles.—According to a note in the April 16th issue of *Nature*, a fine series of photographs of flying bullets, both in free air and in different stages of penetrating through a pane of glass, have been taken in Italy by Dr. Q. Majorana Calatabiano and Dr. A. Fontana, of the Italian Artillery. The apparatus described is a modification of that employed by Prof. C. V. Boys, and these photographs might, perhaps, more correctly be described as skiagraphs, since they are shadow pictures produced on the photographic plate by the light from an electric spark produced by the discharge of a condenser. A blurred appearance which was noticeable in front of the projectile was very similar to that which would be produced by the sparks arising from an oscillatory discharge of the condenser, but the careful precautions adopted by the experimenters to prevent any secondary discharge negative this explanation.

The P.Q. Atlantic Cable System.—We understand that the repairs to the P.Q. Atlantic cable system has been put into the hands of the Telegraph Construction and Maintenance Company, the ss. *Seine* being commissioned for the work, It will be remembered that the *Faraday* was engaged last summer in similar operations, but had to return, we believe, before the cable was put through, and in December last the Compagnie Francaise des Cables Télégraphique chartered the ss. *François Arago* to complete the repair; but after some three months' absence, she has returned disabled, we are told, after having experienced very bad weather.

Electrical Engineering in Austria.—It is reported that Messrs. Schuckert & Co., of Nuremburg, have been in negotiation with the Brush Electrical Engineering Company, Limited, with reference to the acquisition of the latter's interest in the firm of Messrs. Kremenezky, Mayer & Co., of Vienna, the Austrian agents of the Brush Company. The negotiations are, however, said to have resulted unsuccessfully.

Action for Slander.—For circulating a slander on Mr. Carl von Buch, an electrical engineer, &c., of Cornhill, E.C., Mr. Chas. Napier Grant has a verdict against him for £100 damages; but, as counsel remarked, this is one of those cases where the defendant, being an undischarged bankrupt now in Australia, even if the jury found for £10,000, plaintiff would not be able to get anything.

A Cell of High and Constant E.M.F.—Yet another form of cell was recently the subject of a paper at the Paris Academy of Science, and, as usual, the special advantages claimed for it were high and constant E.M.F. The formation of the cell is stated to be as follows:—A plate of retort carbon constitutes the positive pole, whilst the negative pole is a plate of amalgamated zinc. So far, there is nothing particularly novel, however; the positive pole is immersed in a (3 : 1 vol.) solution of potassium bichromate and sulphuric acid, the functions of which are obvious, whilst crystals of the former substance ensure by their presence the requisite strength. In this liquid there is also placed a porous pot containing a solution of caustic soda (sp. gr. 1·05), and within this pot is placed a second porous pot, also filled with caustic soda, but of sp. gr. 1·25. This latter pot also holds the negative pole. It is stated that the E.M.F. of this arrangement commences (after allowing an hour for it to get into good working order) at 2·5 volts, and remains above 2·4 volts for 10 hours; and that the internal resistance is 0·8 ohm. The increase of voltage in this cell over the common bichromate cells appears to be due to the substitution of the alkaline for the acid solution in which the zinc is commonly immersed; but this is, we should think, accompanied by a rapid increase in resistance. The caustic soda will be converted into chromate, and hydroxide will soon coat the surface of the zinc, but the alkaline liquid will lessen the effect. The coating on the zinc may be removed by periodically dipping the plate in dilute acid, and this should be done after every 10 hours' run. For further details of this cell, and accounts of experiments made with it, consult the *Comptes Rendus*, cxxi., p. 251.

The Electrolytic Galvanisation of Iron.—The electrolytic deposition of zinc upon iron surfaces is at present worked under three processes, namely (1) that of Cowper-Coles, (2) of Richter, and (3) of Alexander, the last being a combination of the methods of Schaag and Falk. These systems, however, are not extensively worked, most manufacturers being conservative enough to adhere to the old fusion system with all its well known inconveniences and disadvantages. At a meeting of the Eisenhütte at Düsseldorf, a paper was read by O. Vogel, pointing out the advantages of the true galvanic method over the old fashioned fusion method. He states that it gives a more uniform and thinner coating, which is equally efficient as a protective covering for surfaces liable to rust. There is no loss owing to the formation of dross and hard zinc, and the process is much more easily adapted to complex shapes and surfaces than the fusion method. Of course, the galvanic system has disadvantages, and Vogel thinks these may be summed up in the statement that it requires more men, more time, and more intelligence. In the discussion which followed, the general consensus of opinion appears to have been that the galvanic processes are less adapted for large-scale operations than the old fusion method. The question of galvanising telegraph wire also came up in the discussion and it was considered that the old method was the most suitable for this, because according to Schmidt, the electrolytically galvanised wire will not stand the regulation immersion test. At the same time it would be unfair to consider that finality has been reached in the new methods, and in all probability such disadvantages as they may possess will be got rid of.

Titanium from the Electric Furnace.—Amongst the latest products of the electric furnace is the metal titanium, a metal which hitherto has probably only been seen in small quantities, and rarely outside of the specimen cabinet in a chemist's laboratory. It is an extremely refractory substance; in fact, Mons. Moissan, whose researches with the electric furnace our readers are familiar with, states that it is the most refractory that he has yet obtained, being more infusible than vanadium, and far more so than molybdenum or zirconium. It has only been prepared in the electric furnace at the highest temperature, and by means of a dynamo using 100 horse-power. The general properties of titanium resemble those of the metalloids, and particularly silicon. In a recent issue of the *Bulletin de la Société Chimique de Paris*, Moissan has a paper of considerable length describing his experiments and defining the properties of their product. *Vide Bulletin*, 1895, p. 959.

Electrical Exhibition at Paris.—An electrical exhibition, organised by the Société Internationale des Electriciens, will take place at Paris, May 2nd, 3rd and 4th. The object of this exhibition is to show all the progress realised, and all the applications made in the domestic and medical branches of electricity, and in its instructive or popular aspect. The various exhibits may relate to canalisation (wires, cables, interrupters, circuit-breakers), to lighting (chandeliers, globes, incandescence lamps, arc lamps), to controlling apparatus (manipulating instruments, registering apparatus, meters), to motive power (motors, ventilators, lifts, sewing machines, domestic implements worked by electricity), to heating apparatus (radiators, boiling stoves, ironing stoves), to telephony, clock making, jewellery, medical electricity (static machines, induction machines, galvano-cautery), to instructive and popular apparatus (Ruhmkorff coils, Geissler and Crookes tubes, static machines, condensers, &c.)

Vacuum Tube Lighting.—Our article respecting Mr. D. McFarlan Moore's etheric light experiments, and the photo of himself taken by means of that light, will be fresh in the minds of our readers. We now hear that on 22nd ult. Mr. Moore read a paper before the American Institute of Electrical Engineers in New York, on "Recent Developments in Vacuum Tube Lighting," accompanied by experiments. The hall was lighted by means of these tubes.

A Yankee Wrinkle.—We cull the following smart note from the *Scientific American*. We endorse our contemporary's view that it is "not a bad idea":—

A gentleman once asked a lawyer what he would do provided he had loaned a man $500, and the man had left the country without sending any acknowledgment.

"Why, that's simple: just write him to send an acknowledgment for the $5,000 you lent him, and he will doubtless reply stating it was only $500. That will suffice for a receipt, and you can proceed against him if necessary."

High Frequency Currents and Bacterial Toxines.—It is reported that M.M. D'Arsonval and Charlan have proved by experiments that currents of high frequency attenuate the bacterial toxines. Toxines thus attenuated increase the resistance to infection of animals into which they have been injected.

The Institution of Junior Engineers.—On Friday, May 8th, at 8 p.m., at the Westminster Palace Hotel, a paper on "Notes on Belgian Electrical Engineering Practice," will be read by Mr. A. Anstruther-Thomson and Mr. G. C. Allingham, members.

A Rumoured New Cable.—It is said that a project is on foot for laying a direct cable between Emden, in Germany, and Vigo, in Spain. We are also informed that the scheme is meeting with considerable opposition in certain quarters.

Obituary.—The death is announced of Mr. George Warren, who for the past 34 years has been in charge of the telegraph department attached to the Queen's household.

NEW COMPANIES REGISTERED.

J. L. Pulvermacher & Co., Limited (47,632).—This company was registered on April 22nd with a capital of £1,000 in £1 shares, to acquire and carry on the business of medical electricians and galvanic battery manufacturers, carried on by J. S. Pulvermacher & Co., at 194, Regent Street, London. The subscribers (with one share each) are: G. C. Bradley, 124, Odessa Road, Forest Gate, clerk; W. J. Poplett, 15, The Avenue, Highbury, clerk; H. G. Leatherbarrow, 10, Valimar Road, Camberwell, clerk; A. L. Lloyd, 37, Holsworthy Square, W.C., clerk; H. A. Buck, West Ham House, West Ham, clerk; W. H. Maguire, 45, Duncan Terrace, Islington, clerk; W. F. Howard, 33, Leswin Road, Stoke Newington, secretary. The number of directors is not to be less than three, nor more than five; qualification, £50; remuneration as the company may decide. Registered by G. A. Wingfield, 1, Wool Exchange, E.C.

Telescription Syndicate, Limited (47,635).—This company was registered on April 22nd with a capital of £40,000 in £1 shares, to adopt an agreement with B. Hoffmann for the purchase of his patented inventions for telegraphic apparatus and typewriting machines, and to carry out the business of a telescripter, veloscripter, and telegraph company. The subscribers (with one share each) are: L. Epstein, 28, Victoria Street, S.W., electrical engineer; P. Hoffmann, 152, Palmerston Buildings, E.C., architect; C. M. Owen, 10, Victoria Street, S.W., engineer; B. Hoffmann, 10, Rue Chauchal, Paris, inventor; P. Holyoake, 30, Gower Street, W.C., engineer; C. F. Jones, 9, Victoria Street, S.W., gentleman; C. Scott, 32, Victoria Street, S.W., gentleman. The number of directors is not to be less than three nor more than eight; the subscribers are to appoint the first; qualification, £100; remuneration as the company may decide. Registered by Faithfull & Owen, 11, Victoria Street, S.W.

International Improved Electric Company, Limited (47,636).—This company was registered on April 22nd with a capital of £75,000, in £1 shares, to acquire, develop, turn to account and deal with certain inventions for improved electric glow lamps, and certain registered models, designs, for the same, to enter into an agreement with F. Fanta & Co., to carry on the business of electrical engineers, manufacturers and contractors. The subscribers (with one share each) are:—G. W. Puttman, 56, Mildmay Street, N., engineer; W. F. Smith, 65, Warren Road, Leyton, electrician; W. R. McAthy, 21, Kingswood Road, Wimbledon, accountant; F. L. Koch, 6, Fen Court, E.C, clerk: F. Boyce, 6, Fen Court, E.C., clerk; C. J. Hupfeld, 2, Whittington Avenue, E.C., merchant; W. Dunz, 2, Whittington Avenue, E.C., clerk. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; qualification £50. Registered office, 1, Arundel Street, Strand.

Alderley and Wilmslow Electric Supply, Limited (47,663).—This company was registered on April 24th with a capital of £30,000 in £1 shares, to enter into an agreement with the Alderley Edge Urban District Council for the transfer of the provisional order granted by the Board of Trade for the generation and supply of electricity within its district, and to carry on the business of electrical engineers and suppliers of electricity. The subscribers (with one share each) are:—F. B. Ross, 7, Burnside, Alderley Edge, merchant; A. Crewdson, Alderley Edge, merchant; C. Duckworth, The Mount, Alderley Edge, merchant; A. Midgley, Hurst Lea, Alderley Edge, merchant; E. Agnew, Alderley Edge, agent; J. Royle, Northwood, Wilmslow, merchant: P. Whyman, Osborne Villa, Alderley Edge, merchant. The number of directors is not to be less than three nor more than seven. The first are:—E. Agnew, A. Crewdson, F. B. Ross, and W. P. Fawcus. Qualification £50; remuneration as the company may decide. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, 30, Cross Street, Manchester.

Liverpool Meter Company, Limited (47,678).—This company was registered on April 25th with a capital of £30,000, in £1 shares, to enter into a certain agreement, and to carry on the business of meter manufacturers, mechanical and gas engineers, iron and brass founders, millwrights, metal workers, metallurgists, manufacturing chemists, electricians, suppliers of gas and electricity, &c. The subscribers (with one share each) are: D. de Ybarrondo, 8, Tower Chambers, Liverpool, merchant; A. H. Holmes, 1, Crosshall Street, Liverpool, contractor; A. S. Hannay, Hackin's Hey, Liverpool, cotton broker; A. B. Holmes, 15, Highfield Street, Liverpool, engineer; F. M. Radcliffe, 9, Cook Street, Liverpool, solicitor; W. Ayrton, 9, Cook Street, Liverpool, solicitor; C. H. Wright, 9, Cook Street, Liverpool, solicitor. The number of directors is not to be less than three, nor more than six; the first are the first four subscribers; qualification, £500; remuneration, £50 each per annum, £50 extra for the chairman, and a share in the profits. Registered by T. T. Hull, 22, Chancery Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Eastbourne Electric Light Company, Limited (16,422).—This company's annual return was filed on April 2nd. The capital is £50,000 in £10 shares; 1,065 of these have been taken up, the full amount called, and £10,650 paid.

Barcelona Tramways Company, Limited (6,544).—This company's annual return was filed on April 2nd. The capital is £150,000 in £10 shares; 14,928 shares have been taken up, and the whole amount called and paid.

City of Bath Electric Lighting and Engineering Company, Limited (33,947).—This company's annual return was filed on April 13th. The capital is £60,000 divided into 5,500 ordinary shares of £10 each and 50 founders' shares of £100 each; 3,384 ordinary and all the founders' shares have been taken up; 2,250 ordinary and 50 founders' are considered as paid. The full amount has been called and paid on 1,134 ordinary shares.

Syndicate of Electrical Engineers, Limited (30,351).—This company's annual return was filed on April 8th. The capital is £10,000, in £5 shares (1,900 ordinary and 100 founders'); 1,007 ordinary and 100 founders' have been taken up, and the latter have been considered as paid; £4 per share has been called on 1,007 ordinary, £4,003 10s. has been paid, and £24 10s. remains outstanding.

Birmingham Electric Supply Company, Limited (30,296).—This company's annual return was filed on March 30th. The capital is £200,000, in £5 shares; 30,000 have been taken up, and £5 per share has been called on 20,000, and £2 per share on 10,000; £120,000 has been paid.

Altrincham Electric Supply, Limited (40,795).—This company's annual return was filed on April 8th; 25,000 shares have been taken up out of a capital of £50,000 in £1 shares; 15s. per share has been called, and £18,750 has been paid.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation April 22nd.	Closing Quotation, April 29th.	Business done during week ended April 29th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	102¼	101
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10½— 11	10½— 11	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	49 — 51	49 — 51	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	92 — 93	92 — 93	93	91½
2,993,560£	Do. do. Defd.	Stock	...	...	...	9½ — 10	10 — 10½	10	9⅝
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	14¼— 14¾	14¼ — 14⅝	14⅝	14½
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	163½	...
224,850	Consolidated Telap. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12 — 13	12⅝	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	20⅝	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	9½ — 10	9½— 10	9 15/16	9¾
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	17 — 17½	17 — 17⅝	17 7/16	17½
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18 — 18½	18 — 18⅝	18 7/16	18½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	104 —107	...	
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	130 —133	129 —132 xd	132½	131⅝
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅝ — 18¼	18 — 18½	18 3/16	17⅞
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	129 —132	130 —133	130½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	103	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	112 —115 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4⅛%	...	10½— 11	10½ — 11	10⅝	10½
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16⅝— 17½	16½ — 17½	17⅛	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	23 — 23½	23 — 23½	23½	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 56	53 — 56	55	54½
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	108 —111	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5⅛%	7 — 7⅛	7⅛— 8⅛	8 1/16	7⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½ — 17½	16½ — 17½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅝— 6⅞	6¾ — 7	6⅞	6 11/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —109	108 —111	107⅝	107½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	5 %	0/16— 1/16	0/16— 1/16 xd	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 — 111	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	133 —138	133 —138	136	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½— 4	3½— 4	...	...
146,739£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	96 —101	97 —102	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	97 —102	97 — 102	...	...
54,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8½— 9	9 — 9½	9⅜	9⅛
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 6⅝	6¼— 7	6 1/16	6⅝
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2¼— 2⅜	2½ — 3	2 1/16	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	104 —108	104 —108	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	104 —108	104 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	7/16	1/16	...	1 — 1⅛	1⅛ — 1⅜	1 1/16	1 3/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11¼— 11⅝	11¼ — 11⅝	11⅝	11½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	109½	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	116⅜	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —105	102 —105	102⅜	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	7⅛— 7⅜	7⅛— 8	7 11/16	7⅛
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅛— 8	7⅛— 7⅞	7 9/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 —119	116 —119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14 — 15	14½ — 15½	15	14⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ — 17	16½ — 17	17	16½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8 — 9	8 — 9	8⅝	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	6 %	12½— 13½	12½— 13½xd	12⅝	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	6 %	7⅞— 7⅞	7⅞— 7⅞	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13 — 14 xd	13 — 14	13 11/16	13½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —120	119 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	9 — 9½	9 — 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	10½— 10⅝	10½— 10⅝	10⅝	10½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅞	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9¾— 10¼	9¾— 10¼	10	9⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation. April 22nd.	Closing Quotation. April 29th.	Business done during week ended April 29th, 1896. Highest.	Lowest
£ 90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1⅝ — 1⅞	1⅝ — 1⅞	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	111 —114	111 —114	114	...
630,000£	City and South London Railway	Stock	1 1/16%	1 1/16%	1 1/16%	40 — 42	40 — 42	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2¼ — 2⅜	2¼ — 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1¼ — 1⅜	1¼ — 1⅜	1½	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2¼ — 2⅜	2¼ — 2⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	½ — ⅝	½ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½ — 10½	9½ — 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16½ — 17½	16½ — 17½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	16½ — 17½	16½ — 17½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	107 —112	107 —112	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	22 — 23	22½ — 23½	24	22½
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	... ...	... ...	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	14 — 14⅛	14 — 14⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅜ — 16⅞	16⅜ — 16⅞	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	40½	39½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8¼ — 8⅜	8¼ — 8⅜	8⅜	8⅜

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—5%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.
Electric Construction Corporation, 6 % Debentures, 102—105.
House-to-House Company (£5 paid), 3⅛—3⅜.
Do. do. 7 % Preference, of £5, 8⅛—8⅜.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 8¼—8⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.
Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7—7⅛.

Bank rate of discount 2 per cent. (February 22nd, 1894).

REVIEWS.

Electrical Engineering as a Profession. How to Enter It, and Guide to the Engineering Profession. By A. D. Southam, A.Inst.E.E. London: Southam & Co.

This edition is called "Official Edition." The reason is not apparent, unless from the statement made in the preface that the publication is officially recognised by many of the leading technical colleges, institutions, and universities. From the nature of this work, it will no doubt be recognised by these establishments for the purpose of advertising themselves. It seems also to be well recognised by those firms who, profiting by the craze so prevalent at present to make young men electrical engineers, derive considerable incomes from premiums on apprentices. From the terms stated in this work, upon which firms take in apprentices for training, it strikes us that the training business is perhaps more profitable than the practice of the profession, in the vast majority of cases.

Every manufacturer must feel the crying want for good skilled workmen, while the plethora of so-called electrical engineers, who have been trained on the lines indicated in this work, is only too conspicuous. Young men so trained want to be "professionals" all at once; but their number is so great, and the demand for them so limited, that they cannot command, even after some experience, more than a skilled workman's wages.

The book before us contains information of value to those able and willing to pay for a technical education and a premium apprenticeship. Technical schools and colleges provide more than ample facilities for training the would-be professional engineer; but it seems to us the training of the skilled workman, upon which so much depends, has not been in any way improved, notwithstanding the technical education schemes.

The course recommended for the production of professional engineers is all very well, so far as the scholastic part is concerned; but the two or three years spent in the shops, a few months at one job, and a few months at another, cannot make a practical engineer, but only a sort of educated amateur, for, after all the technical training and the premium apprenticeship is over, in nine cases out of ten the real experience has to be commenced.

An Elementary Treatise on the Calculus, for Engineering Students. By John Graham. London: E. & F. N. Spon.

Correspondents from time to time write to the Electrical Review asking us to recommend them an elementary work on Differential and Integral Calculus. Mr. Graham's little book, which is one of the Finsbury technical manuals, is intended for engineering students and others who have little time to devote to an extended study of these important branches of mathematics. The process of differentiation is explained in the first two chapters. The calculus is then applied to the expansion of functions, and to the determination of maxima and minima values, and of tangents and normals to curves, and radii of curvature. There are numerous practical examples from mechanical and electrical engineering as well as purely mathematical examples. Lord Kelvin's rule for the most economical section of a conductor is considered (§ 86), but it is not made clear what is meant by the constant, *t*.

In the second part of the book the integral calculus is dealt with, but the process of applying the calculus is hardly explained with sufficient clearness to enable a student to master it for himself. A beginner usually finds a difficulty in grasping the precise meaning of the mysterious sign of integration, and, as an extra page or two would suffice to give a clear and concise explanation of the process of summation

denoted by integration, the space taken up would not be thrown away. The application of the integral calculus to mechanical problems connected with belts, girders, pipes, and moments of inertia, is described in Chapter XXIV., and in the last chapter some electrical examples are given connected with the discharge of condensers and the effects of self-induction. This should be a useful little book for students, and also for those who want to rub up their forgotten knowledge of the calculus without diving too deeply into theory.

Small Encyclopædia of Electro-Mechanics. By Henry de Graffiguy. Paris: E. Bernard & Co.

This is the second volume of a series of small cheap works treating in a very elementary fashion of commercial electro-mechanical apparatus. The volume is confined to dynamos.

Beginning with Faraday, the history of the dynamo is carefully traced. Continental machines are briefly described and illustrated with catalogue blocks. It is a work written in a popularly descriptive style, without any scientific or mathematical treatment, and will no doubt be useful to many non-technical readers.

There are to be 12 volumes in the collection, so that for something less than a guinea, an electro-mechanical library may be furnished in the French language.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page 554.*)

Mr. G. L. Addenbrooke said it was difficult to take up the matter in a proper way after the very able speeches they had just been listening to, and he would speak rather generally than to Mr. Sinclair's paper, which might, perhaps, be taken rather as a record of telephone work in this country at the present day than as an attempt to go into more debatable ground, except in connection with the switchboard. He himself was connected with the telephone company from 1883 to the end of 1886, nearly four years, and during that time he thought the telephone company might be said to have got into shape; it was more or less a scramble up to that time, but the great problems they were now discussing first became apparent about that date, and he certainly took a great deal of interest in working at them. The first point they had to consider, he thought, in the question of telephone service was this: they had two other services; they had the post, which took a certain time, say, 12 or 14 hours to most parts of the kingdom; the next was the telegram, with which, under favourable circumstances, it took an hour to get a reply; then they came to the telephone. Well, he had always felt, and he believed it was really the fact, speaking commercially as a user of telephones, that an extremely rapid service was of far less moment to commercial men than thoroughly good speaking. The question of whether one had to wait five minutes, or even ten minutes or a quarter of an hour, before getting there, was nothing compared with the necessity of being able to hear thoroughly well. He had the pleasure of speaking through to Paris when that line was opened, and to Dublin, and, notwithstanding the great distance of those lines, and the fact that part of them was under water, the speaking was better than on most of the lines belonging to the National Company, which were only two miles long. There certainly had been a great improvement in London lately through the adoption of the double wire, but the service in the country was lamentably behind, and in the country the telephone was of more real importance than in the metropolis. The service would be worth double in the country what it was in London, if it were made what they knew it could be made, considering the improvements in the construction of apparatus now. It was, further, worth pointing out, that many of the difficulties they were battling with in London did not occur in the country, for which the existing switchboards and other arrangements which were all worked out, answered perfectly. A first class telephone service in the country would be an enormous aid to business men in that competition in which they were all engaged with other countries; far too much of this exchange question was being made to the exclusion of other matters of greater importance to the community, where they had a large population, as in Lancashire and in the Birmingham district, and the trunks about the district were only a few miles long, they ought to have so perfect a system that it would be almost like speaking to the next room. It was not necessary to get through in half a minute; all that was wanted was, that people should be able to speak perfectly when they did get through, and that they could get the answer they wanted. As regards co-operation of subscribers, that was no doubt a very technical matter, and he could appreciate the position the company took up, especially in London, for when they had to deal with a good many trunks between exchanges, they could not expect a subscriber to go through, from trunk to trunk, as they could if all the lines came into one exchange. He thought Mr. Sinclair had hardly done justice to previous work in the few remarks at the latter end of his paper. This happened to be a matter in regard to which he could speak from personal experience. Mr. Sinclair said he had found it necessary to have a central trunk service for London. Of course that was literally true, but he thought not quite in the manner people would gather from the paper. The telephone central trunk service was established 10 or 11 years ago, and as it formed, he believed, almost a distinctive feature in the London service, in which the work was original, it was a very important matter, and further, it had attained to very great dimensions. Perhaps he might relate a little bit of history. He got into the telephone company about 1883, and towards the end of that year, or the beginning of 1884, this question of trunk communication began seriously to crop up, owing to the difficulty of getting through to other exchanges, particularly to some of the eastern exchanges, and those in the City. The matter was debated for some time, and a meeting was held at the Euston Hotel. Mr. Morgan was the managing director at that time. He (the speaker) did not know exactly why he was at that meeting, but he was there, although he took a small part in the discussion, and perhaps he could speak better of it, because he did not take part. Practically, at that meeting, the trunk system was decided on, and it was put into practice in a few months. Their board was designed by Mr. Hawes, and the London exchange system was really put down on a basis which had gone on ever since. Therefore it was only fair that some credit should be given to those who really did initiate that service. Those who were at that meeting, as far as he could recollect, were as follows: Mr. T. Fletcher, Mr. Phillips, Mr. Ashmore, Mr. Clay, Mr. Hawes, Mr. Ullett, and himself.

Mr. Hawes congratulated Mr. Sinclair upon having brought this subject forward. He was himself no longer connected with telephone work, but he had always felt that there was a great dearth of papers of this kind. He hoped they would have many more of them. There were one or two points regarding which he would like a little more information than Mr. Sinclair had given. In London, at the present time, he believed call wires were used between the exchanges for working trunks or junction wires, and he thought it would be useful if Mr. Sinclair would tell them what proportion of trunks they worked in that way; that was to say, how many junction wires one call wire served. These junction service call wires were used in telephone exchanges many years back, soon after the amalgamation of the two companies in fact, and they had been used more or less ever since. At one time they were almost entirely abandoned, when multiple boards were beginning to be worked, but now they were used fairly regularly. Another point about which he would like to have information, was as to the motors used in the exchanges; the generators for the surging currents were, he believed, driven by small motors, and it would be interesting to learn what motors were found most serviceable. As to flat boards, he did not agree with the points Mr. Sinclair had urged in their favour. Multiple switchboards were first used in England by the United Telephone Company; these were designed by the speaker, and were intended to be used in an upright position, but it was suggested, he thought by Mr. Clay, that they should be used lying down, and the reason for placing them in that position Mr. Sinclair said he did not quite understand. In those days they had no experience of how many subscribers one operator could attend to on a multiple board, and they thought they had better err on the safe side, and so by placing them on their backs they made provision for one operator for each 50 subscribers. This, as it turned out, was very much more than was required, and the boards could have been worked far better standing upright. This board should not be taken altogether as an example as regards the defects of flat boards, for having been designed for use upright, several of the contacts were affected by dust and dirt, and there was trouble from that cause. They had also much trouble about repairs, and he could not see how any flat board got over that difficulty. A telephone system had to be constantly at work now, and therefore if any repairs were required they must be carried out while the switchboard was at work. Coming to the question of fitting up additions to the boards, when a board was started with a certain capacity, new jacks would have to be added from time to time when enlarging, and the addition of those jacks while the boards were in use was a tremendous piece of work. It was almost impossible to get openly at your work and to see what you were doing satisfactorily with flat boards. The difficulties, he should say, were enormous. Dealing with the size of the board, and taking Mr. Sinclair's figures, it appeared that a switchboard on the flat system for 6,000 subscribers would be one yard square. Now, if they took a table a yard square, and tried to sit on one side and reach over to the opposite corners, they would find it almost, if not quite, impossible. They would have to stand up to the work, and if an operator had to keep on jumping out of her chair for a large proportion of the calls, it would not help to expedite matters. Another matter he would like Mr. Sinclair to tell them about from his experience, was as to the cords getting entangled as they came down on the board. It was certainly the case with the board with which he had had experience. It appeared to him that in pulling out one cord they were very liable to pull out another with it. Mr. Kingsbury referred to the dirt getting in, and he (the speaker) thought it was a very serious matter. He would go further than Mr. Kingsbury went, and would say that whatever sort of multiple board was used, the dirt would cause leakage from line to line; they would get the same amount of cross talk from line to line through dirt, whether it was the series system or the arc system. The point referred to by Mr. Sinclair of up and down junction wires was of interest, and he thought a little more might have been said about them with advantage. At first sight, with junction wires between two exchanges, it would appear to be most economical to use them irrespective of what class of calls was put on, that is to say, whether from B exchange to A exchange, or from A to B; but when the matter was considered further, and the details of the work examined, it was evident there was a great benefit in dividing the junction wires into two parts, doing the work in one direction on one part, and in the other direction on the other

part. He fought very hard for that in the old days, and at last got it done, and the wires were divided for use in this way. The advantage was that, although they were not using them quite as economically in one respect, they could be worked and cleared much quicker. Talking about working quickly, Mr. Addenbrooke's remarks about time not mattering must be received with some caution. He thought that even in London, if he had to wait five minutes for every call, he should be very much annoyed. He did not have to wait five minutes on the average, he was happy to say, as an ordinary subscriber. Mr. Addenbrooke had mentioned what he (the speaker) wanted also to say about the central junction exchange. That was a very old idea indeed in London, and it was an idea which very many people had claimed as entirely their own; but all the same it was a good one, and the opening of that exchange had been of great benefit to the system. Mr. Preece had referred to the express system in Chicago. He believed they had something approaching the express system in London. The National Telephone Company worked a system for stockbrokers only, and that system he had always heard was a practically perfect one. That exchange he believed was worked by a very ancient apparatus, discarded in other exchanges, and it was merely due to the fact that there were no junction wires, and only a comparatively small number of subscribers, that the service was so extremely rapid. Then there was the question of the subscriber doing the work of ringing up the subscriber he wished to speak to, instead of the exchange operator doing this, as Mr. Preece had described was the case in Berlin. When a subscriber had this work to do himself, he did not notice the time that elapsed so much as if the operator did it, but the latter method was really the more rapid. There was also this disadvantage about that method, that supposing the connection was not made by the exchange, the subscriber might go on ringing until he was black in the face, without result.

Mr. Somerville said Mr. Sinclair had mentioned as a weak feature in the American divided board, that no connection was made without being dealt with by two operators. It was certainly a very weak feature of any board at which one operator could not complete any connection asked for. This difficulty was not altogether absent, however, from the multiple switchboards used generally in this country. They were informed that the length of each section on these boards was 6 feet 6 inches. It therefore followed, with the upright boards, that an operator was expected to stretch a distance of 3 feet 3 inches to either side of the point opposite which she sat, and that ought to be done without any inconvenience to her neighbours, or interrupting their work. She might be able to accomplish it if she had plenty of room, but they had to remember that there were four operators sitting in front of each section, so that the space allotted to each was only 19½ inches. In the case of flat boards matters were even worse. They had been told the width of the board was 40 inches. To make some connections an operator, therefore, was called on to insert a plug in a jack, which, being on the opposite side of the board, was not less than 4 feet distant from where she sat. Taking into account that there were eight operators working in the same section, and that a plug and cord had to be passed between the other cords in use at the time, he thought they would agree that the operation was nearly impossible. In practice the operator did not attempt it, but asked for and received assistance in making nearly 25 per cent. of the connections required, so that the weak feature mentioned was not by any means absent from the switchboards in use in the National Telephone Company's service. With regard to what had been spoken of as the listening keys, those now universally used by the National Telephone Company were not by any means good, for they were responsible for introducing into the system a very grave defect. With this key the operator had an opportunity of overhearing any conversation which was carried on by the subscriber for whom she had made the connection, or, in fact, any conversation passing through the exchange. It was useless to say that it was never used for that purpose; it could be so used at all times, and is thus the source of one of the very worst defects which can exist in any exchange, viz., the absence of privacy. It was also to this key, as at present used, that subscribers were indebted for the annoying interruptions by operators and their continual questioning, "Have you finished?" He was very much pleased to hear Mr. Sinclair advocate the use of flat boards and the call-wire system; although, judging from results, he should imagine that until quite recently his advocacy must have been of a very mild type. Referring to the call-wire system, he took it to be the Mann system that was now being adopted in Manchester. It was very interesting to hear him praise it, and no doubt by-and-by he would advocate it in London. His objections to its use here were without foundation. The real difficulty was in connection with the static capacity of the signal wire. That, however, could be overcome, and there was no reason whatever why the operator at King's Cross, when connecting with the operator at Lime Street, should cut herself off from her call wire, or join her call wire with its 50 subscribers to the call wire to the City.

Mr. Dane Sinclair, in replying on the discussion, said Mr. Kingsbury, with his usual ability, had put his case so ably, that he (the speaker) began to doubt himself, and that was saying a great deal. Mr. Kingsbury condemned the call wire system, and if he took his experience of it from the Law system, as Law system, it was not to be wondered at. When he (the speaker) first joined the telephone work in Glasgow, the Law system was at work with 200 or 300 subscribers, and was so unsatisfactory, that after eight months it was turned out. But in this, as in all other things, they looked for developments. There came a development in the system, which had been referred to by the last speaker as the Mann system. That was put in by Mr. Mann at Dundee, without knowing that it had been previously put in by friends on the other side of the Atlantic. This made a great deal of difference between the call wire under the Law system and the other. The difference was that with the Law system, as first used, every subscriber had the power of breaking into the circuit and cutting off all the subscribers on the other side of him. Out of 50 subscribers he could, under certain conditions, cut 30 or 40 absolutely out of touch with the operator. That and the make and break in his apparatus more than counter-balanced the advantages. When they came to the other call wire system, the subscriber could no longer break the circuit, but had to wait his proper turn, which made all the difference. It had been a very serious question, and was receiving much attention for a number of years. In a great centre like Glasgow, where a new exchange had become necessary, the question had to be gone into fully, and he could tell them that at a meeting of experts called from all parts of the country, it was laid down that where you had an exchange with no junction or trunk wires, then —although a great many of these experts were opponents of the call wire *per se*—under that condition the call wire did give perfect service. Therefore, when it came to deciding, where they had an exchange with a large proportion of local work, they got, with the second system, the advantages without the disadvantages. In his humble opinion, notwithstanding all that had been said against it, he still thought that decision was right. Coming to Mr. Kingsbury's remarks with regard to the flat board, there was really no time to go into the matter deeply; but Mr. Kingsbury described how a girl could take a complete circle with the upright board, whilst she could not do so with the flat board. On neither form of board does an operator need to describe a complete circle. In the days when this was being discussed, an experiment was made by placing a table on edge, and the gentlemen present were set to see whether they could reach higher stretching upwards, or further when the thing was flat in front of them. It was found that they could reach further on the flat to the right hand and the left, but could not reach quite so far in front as when the thing was in a vertical position. He was standing by observing this calculation, and he came to the conclusion that there was so little difference between the two, that it was absolutely fudge to make it a point one way or the other. That was to say, there was nothing so serious in it as to make it a question worthy of grave consideration. Then Mr. Kingsbury gave other reasons why the flat was not so good as the upright, and stated that there were various difficulties. He (the speaker) supposed there were difficulties; but he had yet to live to see the switchboard with no difficulties. Therefore it came to a choice between a series of difficulties in one case and a series of difficulties in the other. One speaker had said that it was a serious matter to increase the number of jacks on the flat board, because it would have to be done when it was at work. His reply was that it was not necessary to do this when at work. The few hours when they were not at work in the evening was quite sufficient. When it came to the question of the flat board in use to-day, and the upright board in use to-day, he could say that it was a more simple matter to lift a row of jacks out of their place on the flat than to get them out of their place on the upright; but there was not very much in it. He was not going to discuss the point referred to later by Mr. Preece, viz., the difficulty for a man to get down amongst these wires to work. It was difficult, but it was not impossible; and as regards the other point raised by Mr. Preece, they had to train men to behave themselves even when in close proximity to someone of the opposite sex. It was not impossible, for they were carrying this thing out in practice, and he had not heard of any detrimental effect. Mr. Binswanger gave the crux of the situation when he said that the work was transferred from the operator to the subscriber, and this had a great deal to do with the National Telephone Company coming to the decision as to whether they should use the call wire on flat boards or not. They put it in at Glasgow without being able to get any other opinion than that of their own experts. But when it was finished they thought it would be a gracious thing to do to ask the subscribers whether they liked the older system best or the call wire system, and it was then that 95 per cent. of the subscribers stated their preference for the call wire system. Mr. Kingsbury had referred to the fact that there were fewer calls at Glasgow with the call wire and flat board than at Manchester. That was a curious coincidence, for the evidence given before ihe House of Commons calls were taken on a specified day; but that happened to be holiday time in Glasgow, and that accounted for the fact that the Glasgow figures were so low. Long before he left Glasgow the calls were very much more than six; with the old boards they were somewhere about 10, and his impression was that to-day they were something like 13. That did not bring them up to Manchester, and Liverpool was higher still. Mr. Preece's remarks came with such weight and such force that it made him think once or twice before knowing how to reply to them. They all knew that Mr. Preece had advocated, and rightly so, a metallic circuit system from the beginning of telephony, and great credit was due to him in that he was so early a champion of a good cause. Perhaps it would be irreverent for him (the speaker) to enter into the *pros* and *cons* that it took so long for the different companies to consider. There was the commercial element to consider as well as the engineering. He was not going to say that he ever knew a telephone company in this country which did not encourage its engineers in every way to give a perfectly good service; but when it came to a metallic circuit it was a great question. At Manchester they were invited to put the lines down underground, and there the service was likely to last their time. When Mr. Preece spoke of Berlin, he quoted the very reason why he (the speaker) liked the call wire; it threw the responsibility of actual work from off the hands of the operator into the hands of each individual subscriber, but with this difference, that if the subscriber who was called up did not respond, the subscriber calling got an instantaneous reply from the exchange as to what the reason was. He was assured that he had been connected, and that was, perhaps, the greatest reason for the success of the call wire as compared with the battery or magneto system. When the signal was given to the exchange, they wanted an absolute certainty that when they did something they would get something. With a ringing system they might call, and the indicator

might drop, but the operator was going to answer when she was ready. He did not mean for a moment to suggest that the operators did not answer as quickly as possible, but as between the two systems, in the one case the subscriber commanded the situation, and in the other—well, he did not. Mr. Hawes and another speaker had referred to the central trunk exchange in London. He supposed they all agreed that a great many people thought they had invented that system; not that he thought there was a very great deal in it in itself. After a little time, like many another good system, it was carried too far, and in practice they had to undo a great deal of it. They found, taking two small exchanges in the suburbs of London, that the wires must run into some central point where they could be joined on to other exchanges. But taking any big city with 20,000 calls per day between two exchanges, could anyone explain what was gained by putting all those calls through a third point or exchange. When it was looked into it was found that only one central exchange was required for the overflow work between the great exchanges, and for being able to take wires from all the small branch exchanges that could not have direct junction wires to every other exchange; that was the system that was being worked out in London to-day, and it was a much more important part of the service than one would expect. As he had said in the paper, any exchange which had 40 messages from or to any other exchange was provided with direct junction wires, but if the messages were fewer than that they went through the central exchange. He was afraid they would have to take the will for the deed, and accept those few, unconnected, and rambling remarks, as the reply to their able, gentlemanly, and polite criticisms.

Physical Society.

ORDINARY MEETING, APRIL 24TH, 1896. Captain W. de W. ABNEY, President, in the chair.

Mr. APPLEYARD read a paper on THE ADJUSTMENT OF THE KELVIN BRIDGE.

In a recent paper read before the society, Mr. Reeves had described a modified form of Kelvin bridge in which a double adjustment was necessary. The author proposes to employ two wires stretched side by side, with a sliding contact in connection with the galvanometer on each. These contacts are rigidly connected together so that the segments into which one wire is divided necessarily bear one another the same ratio as do the segments of the other wire. Hence a single adjustment is sufficient to give balance.

Mr. REEVES said that apparently the author had completely missed the object of his (the speaker's) paper. For the object there aimed at was to make use of such sets of resistance coils as are always to be found in any laboratory. In the author's arrangement, it would be necessary to carefully calibrate the two wires, and also, since the resistances used must necessarily be small, to determine the resistance of the contacts.

Prof. AYRTON (communicated) said the author's suggestion was ingenious, but did not obviate the necessity for much of Mr. Reeves's "addition." Further, Mr. Reeves's proposal to employ ordinary resistance boxes was not made because such resistances are absolutely necessary, but because more they are to be found in any electrical laboratory, their use saves the expense of such a wire resistance accurately calibrated as Mr. Appleyard employs.

Mr. APPLEYARD, in his reply, said that his instrument was designed for use in a factory where the time saved in making a series of tests was of more importance than the cost of the instrument.

Mr. J. FRITH read a paper on THE EFFECT OF WAVE FORM ON THE ALTERNATE CURRENT ARC.

The author finds that an arc has the power of modifying the wave-form in a circuit in which it is included. Thus, in the case of a dynamo for which, on open circuit, the curve of E.M.F. was decidedly peaked, it was found that when this dynamo was employed to feed an arc that the curve became changed to a flat topped form. It is interesting to remember that the candle-power of the arc is greater when the wave form is flat topped than when it is peaked. By altering the resistance in series with the arc, it is possible to alter the character of the curve, for as the resistance in series with the arc increases, the arc affects the wave form less and less. In some recent experiments described by Dr. Fleming, a resistance of about 7 ohms was used in series with the arc, so that the wave form of the generator, which is not an efficient form, was forced on the arc. In practice, however, where a resistance is not used in series with the arc, this is not the case, and the differences between the efficiency obtained for alternate current arcs in the laboratory and that claimed in practice may thus be accounted for.

Mr. BLAKESLEY said it seemed as if the more nearly the alternate current resembles a direct current, and the longer in each period the current remains constant, the greater is the efficiency of the arc.

Mr. PRICE asked what was the cause of the reaction of the arc on the wave form.

Mr. TREMLETT CARTER asked whether previous observers results were vitiated by this action of the arc on the wave form?

Prof. AYRTON (communicated) considered the author's suggestion of great importance as bearing on the question of the efficiency of the alternate current arc.

Prof. S. P. THOMPSON said that the dynamo employed by the author was one in which there was a large quantity of iron in the armature, so that the self-induction was large. Was it not on account of this large coefficient of self-induction which would tend to keep the current constant, that the arc was able to alter the wave curve? If an arc is connected to the mains of a supply station in which a number of machines in parallel are feeding a number of lamps, would the arc still be able to affect the wave form of the current?

Mr. TREMLETT CARTER asked if the author had tried the effect of replacing the arc by a resistance, such that it would absorb the same volts as did the arc, and comparing the curves for the current and impressed P.D. with those obtained with the arc.

The author in his reply said that the effect of the self-induction of the machine was shown in the curves. Current curves had not been taken with the arc straight on the machine. The current and self-induction were the same for all the curves, the voltage of the machine being increased by increasing the field when resistance was placed in series with the arc. When, as is commonly the case, special machines are used to supply arcs, and the load consists solely of arcs, the arcs could alter the character of the wave form. If the arc is replaced by a resistance the wave form is of the same type as is obtained for the E.M.F. of the machine on open circuit.

The society then adjourned till May 8th.

ON A PHENOMENON OF CROOKES TUBES, AND ON AN EASY METHOD FOR THEIR PREPARATION.*

BY Q. SESTINI.

A PHENOMENON which cannot be overlooked among the many to which the important discovery of Röntgen gives rise, is that of the variation of the intensity of the Röntgen rays, that is the different time of exposure which is required with such a tube to obtain images of a given intensity.

Professors Battelli and Garbasso in their important memoir on the Röntgen rays, have emphasised this phenomenon in the following terms:—

It seems that the Crookes tubes used for the production of the cathodic rays go on improving if used for some hours. Therefore, if we cause such a tube to act for a day, for instance, we may obtain in the evening the same impressions in a few seconds, which in the morning required an exposure of some minutes.

Every one will recall the experiments of Crookes in which he caused the platinum electrodes of a Plücker tube to absorb the last traces of nitrogen contained in the argon enclosed in the tube. Hence it is natural that in the interior of the tubes exposed to the discharge of an electrical machine, or of a Ruhmkorff coil, should undergo gradual variations by the effect of the absorption of the electrodes.

It seems to me that the variation of the Röntgen rays may be ascribed to this fact, since the tubes, as they are sold by the manufacturers, have not undergone a sufficient rarefaction to have an abundant production of the cathodic rays. This degree of rarefication is augmented by the absorption which the electrodes exert upon the gas inclosed, and when, finally, the increased rarefication offers too much resistance to the passage of the current, the intensity of the cathodic light diminishes anew.

The experiments which I have been able to institute may be united under three groups:

1. Spectroscopic researches on the variations of the spectra in the tubes; 2. Proofs of images on the photographic plate protected from the rays of ordinary light; 3. Direct proofs with exhausted Crookes tubes, into which minimum quantities of gas have been introduced.

The author commenced his spectroscopic researches with a Crookes tube of the ordinary form (pear-shaped), the anode consisting of a little spear of aluminium supporting a revolving plate in the form of a Maltese cross, and the cathode in the form of a disc placed at about a centimetre from the wall of the tube. This tube gives a distinct production of cathodic rays which may be recognised by the green fluorescence which they produce on the walls of the tube, and by the shadow of the cross on the wall opposite to the cathode. But there was diffused in the entire tube and most manifestly in the neighbourhood of the cathode a well marked rose-violet luminosity. This luminosity caused the cross of the cathode to act in a more lively manner. I examined with the spectroscope in a completely dark chamber the light emanating from the cathode, and I was able to observe a spectrum divided into three bands, becoming more feeble towards the right. The first comprised two very distinct lines of the wave lengths 523 and 515; the second five lines having respectively the wave-lengths, 471, 465, 460, 455, 451, and the third band comprising four lines corresponding to the wave-lengths, 428, 424, 420, 417. There can be no doubt but this is the spectrum of the negative pole of nitrogen, as obtained at a very high rarefication.

I cannot conclude without mentioning that a different interpretation of the phenomenon has been given by Prof. Blaserna, who is of opinion that "we must search for the cause in a slight disaggregation of the glass, produced at the point struck by the cathodic rays; a disaggregation imperceptible but necessary for the formation of the Röntgen rays."

Now, independently of the fact, it seems to me to have been sufficiently demonstrated that the Röntgen rays are formed only when the greater part of the gases remaining in the tube have been absorbed. The disaggregation of the glass cannot be regarded as the sole cause of the phenomenon, since when this has once taken place, no diminution of the cathodic rays ought to be manifested in Crookes tubes.

* *Il Nuovo Cimento*, February, 1896.

Summing up the results of the above experiments, we may conclude that:—

1. The variations in the intensity of Röntgen's light are intimately connected with the quantity of gas absorbed by the electrodes of the tubes.

2. It does not occur in the manufacture of Crookes tubes to push the final rarefication to such a point as can be reached only with a perfect machine and in a very long time; then to refill the tube, *quasi*, exclusively with a gas (*e.g.*, watery vapour) which may be easily absorbed by the metallic electrodes, and push the final rarefication to a few millimetres of pressure.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn*, *London*, *W.C.*, *to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

7,760. "Improvements in double-pole switches for electric lighting." F. W. Heaton and H. Smith. Dated April 13th.

7,789. "An improvement in electric arc lamps." J. Brockie. Dated April 13th.

7,791. "Improvements in electric stop-motions for engines." L. St. Peter. Dated April 13th.

7,794. "Improvements in shade holders for incandescent electric lamps." H. A. C. Hellyer. Dated April 13th.

7,834. "Improvements in underground systems for electric railways." A. S. Krotz, W. P. Allen, and O. S. Kelly. Dated April 14th.

7,854. "Improved means for regulating electric motors." Otis Elevator Company, Limited. (Otis Bros. & Co., United States.) Dated April 14th.

7,881. "Improvements in electric current transformers and method of cooling the same." J. Devonshire. (W. S. Mood, United States.) Dated April 14th.

7,882. "Improvements in regulating alternating current electric motors of the induction type." J. Devonshire. (W. B. Potter, United States.) Dated April 14th.

7,883. "Improvements in regulating alternating current electric motors." J. Devonshire. (C. P. Steinmetz and E. J. Berg, United States.) Dated April 14th.

7,884. "Improvements in safety devices for alternating electric current power systems." J. Devonshire. (E. J. Berg, United States.)

7,885. "Improved compound mould for forming incandescent electric lamp bases." J. Devonshire. (J. H. & A. Pederquist, United States.) Dated April 14th.

7,896. "Improvements in electrical hair cutters and singers." F. M. Bell and J. L. Sloss. Dated April 14th.

7,928. "Electric signal indicator." M. Mercier. Dated April 15th.

7,973. "Improvements in electrical accumulators." A. Heil. Dated April 15th.

8,062. "Improvements relating to electric railways." P. W. T. Davies. Dated April 16th.

8,067. "Magneto-electric governing appliance for steam engines, water-wheels, and such like apparatus." R. P. Wilson. Dated April 16th.

8,068. "Magneto-electric regulating and controlling appliance for dynamo and other electrical apparatus, adapted also for indicating and recording purposes." R. P. Wilson. Dated April 16th.

8,080. An improved electrical accumulator under pressure." E. Commelin and R. Viau. Dated April 16th.

8,141. "Switch apparatus for electromotors with automatic resistance regulator." Siemens Bros. & Co., Limited. (Siemens and Halske, Germany.) Dated April 17th.

8,163. "A new or improved alarm clock and apparatus for automatically operating electric signals at definite hours." I. Mesmer-Weber. Dated April 17th.

8,169. "Electric lighter for incandescent gas lamps." P. Meyer. (Date applied for under Patent, &c., Act, 1883, Sec. 103, September 20th, 1895, being date of application in United States.) Dated April 18th.

8,185. "An improvement or improvements in the method of raising or lowering electric light fittings, gas fittings, and the like." P. G. Ebbutt. Dated April 18th.

8,208. "A new or improved make of housing or troughing for electric wires." J. Row. Dated April 18th.

8,210. "Improvements in means for automatically controlling the carbon feed in electric arc lamps." H. J. Fisher. Dated April 18th.

8,216. "Improvements in electric motors and dynamos." W. E. Gray. Dated April 18th.

8,228. "Improvements in armatures for electric generators or motors." Siemens Bros. & Co., Limited, and E. F. H. H. Lauckert. Dated April 18th.

8,234. "Improvements in prepayment meters for gas or other fluid, or for electricity." L. S. Burchard. (W. Webber, United States.) Dated April 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price*, *post free*, 8½d. (*in stamps.*)]

1895.

530. "An improved electrical current reverser and testing key. R. H. Tonking. Dated February 22nd, 1895. The contacts are supported on pillars and are so arranged that a rubbing contact is made between the various parts. The reversal of the galvanometer or "earth" and "line" terminals is effected by a single movement of the key lever. 3 claims.

4,490. "Improvements in dynamo electrical machines." S. Z. de Ferranti. Dated March 2nd, 1895. Relates to improvements in disc armatures for alternate current generators. The bobbins are made in pairs with an insulated non-magnetic holder on each side. The holders are tightly pressed together and then riveted or screwed and are fastened through lugs to the revolving wheel. The holders being carried upon supports insulated from the main frame, the insulation between the bobbins and holders need only be strong enough to withstand the electromotive force developed by one or a pair of bobbins. 9 claims.

7,990. "Improvements in telegraphy and apparatus therefor." F. H. W. Higgins. Dated April 22nd, 1895. Relates to a method of and apparatus for printing telegraphic messages in large letters so that they can be seen at a distance. The message to be transmitted is set up in type in a holder which is propelled along a guide so that the type slide beneath contacts which close circuits through the electro-magnets of the receiver. The receiver comprises a number of printing wheels placed side by side so as to equal the width of the letters to be printed, and these printing wheels are controlled by the electro-magnets, so that as long as a current is sent through a particular magnet the printing wheel is caused to mark the paper which is drawn continuously under the wheels. 9 claims.

8,810. "Method of and apparatus for directly indicating the value of electrical resistances." Siemens Bros. & Co., Limited. (Siemens & Halske, Germany.) Dated May 3rd, 1895. The apparatus enables the value of a resistance to be read off from an indicator, notwithstanding that electromotive forces are combined with the resistance. The method depends on the fact that if the currents in the battery and galvanometer branches of a Wheatstone bridge be varied, the ratio of the variations is proportional to the resistances in the arms of the bridge. The inventors provide an electro-dynamometer which indicates the ratio between the current in the battery and galvanometer branches when the battery branch is opened and closed, and this ratio in conjunction with four known resistances in the bridge arms will give the fifth unknown resistance in the bridge if the only electromotive force in circuit is that of the tubing battery. 4 claims.

10,903. "Improvements relating to automatic safety devices for electric currents." J. B. Stone and S. Barnes. Dated June 1st, 1895. Instead of a fuse a switching device is employed in conjunction with an electro-magnet so arranged that when the current rises beyond a predetermined maximum the armature of the electro-magnet is attracted and permits the switch to operate under the influence of a spring and so open the circuit. Means are provided to prevent dangerous sparking at the contacts, the circuit being arranged to be finally broken between two pieces of carbon which are short-circuited by the metal contacts when the circuit is unbroken. 13 claims.

1896.

2,545. "Improvements in automatic current regulators." H. H. Lake. (S. C. C. Currie, U.S.A.) Dated February 4th, 1896. The regulator consists of a rod whose expansion operates to control the resistance in circuit. This regulator, however, is only switched into circuit by a magnetic switch which acts when the current rises above the proper amount. 10 claims.

2,717. "Improvement in controlling switches for dynamo electric machines." F. H. Royce and E. A. Claremont. Dated February 6th, 1896. Relates to a "many way" switch combined with a resistance controlling switch, and so arranged that the "many way" switch can not be operated until all the resistance has been thrown into circuit. Sparking at the "many way" switch is thereby prevented. 1 claim.

2,767. "Improvements in telephonic systems and in apparatus for use therein." A. R. Bennett and G. J. Somerville. Dated February 6th, 1896. Relates to metallic circuit systems in which communication is established between the subscriber and the operator by means of an earth circuit provided with a battery, and has reference to various improvements in the devices for enabling subscribers to communicate with the operators. 10 claims.

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LIST OF

ELECTRIC LIGHT CENTRAL STATIONS OF THE UNITED KINGDOM.

* No return since last year. Abbreviations:—H.T., high tension; L.T., low tension.

ABERDEEN.—Corporation. L.T. three-wire system. Two Willans and Robinson engines, 40 I.H.P., three 80 I.H.P., two 200 I.H.P., four 90 nominal H.P. Babcock boilers. Underground mains, bare copper strip in concrete culvert, Callender and British Insulated Wire Company's cables. 12 10-ampère arc lamps used for street lighting. Private lighting equivalent to 17,100 33-watt lamps. Price per unit for private lighting, 5d.; for public lighting, 4½d.; for motive power, 4d.; gas 3s. 4d. Coke used in boilers. Arc lamps run 4 in series across 220 volts. City Electrical Engineer, Alfred Blackman, Corporation Electricity Works, Cotton Street, Aberdeen.

ABERYSTWITH.—Corporation. System of public and private lighting. No further information.

ALTRINCHAM.—Altrincham Electric Supply Company, Limited. H.T. alternate current. 2 Lanc. boilers by Tinkers, 2 100 H.P. engines by Browett Lindley & Co., 1 gas engine, 70 H.P.; alternators by Manchester Edison & Swan Company. Concentric cables drawn in cast-iron pipes for high tension, concentric armoured cables buried in ground for low tension. Between 9,000 and 10,000 8-C.P. lamps connected to system. Coal used, Household screenings. Price per unit, 7d.; gas, 3s. 3d. Cost of works, including distribution system, meters, &c., £15,000. District is a very scattered one, consumers being supplied 4 miles from generating station. Engineer-in-Chief, Edward W. Cowan, Vicarage Lane, Bowdon.

AMBLESIDE.—A small system of electric lighting is in operation here.

ST. AUSTELL.—Veale & Co. L.T. system. 3 compound engines aggregating 160 H.P. Underground mains. 9 arcs and 1,600 incandescent lamps for private lighting. Several motors are used for printing, grinding, stone-masons' work, &c. Engineer, F. H. Headley, St. Austell.

AYR.—Burgh Police Commissioners. H.T. alternating, with 4 sub-stations and L.T. network, 2 200 H.P. Marshall compound condensing engines, combined with Siemens fly-wheel alternators running at 95 revolutions, 2 25 H.P. Bellis engines for exciters, and 1 60 H.P. Bellis engine for 25 kw. alternator. Callender's mains in cast-iron pipes for high tension, and armoured cables for low tension. 25 arcs for street lighting. Capacity of works, 7,000 8-C.P. Price of gas from 3s. 9d to 4s. 3d. Cost of works, including 3,000 yards extension mains, £21,000. Engineer-in-Chief, Ernest G. Pink.

BATH.—Bath Electric Lighting Company. H.T. alternating system. Thomson-Houston machines for street lighting. Brush Company alternators for private supply. Babcock boilers, Raworth and Browett-Lindley engines. 84 arcs for street lighting, 10 arcs and 11,231 8-C.P. incandescent for private lighting; capacity of station, 10,000 incandescent and 200 arcs. Callender underground mains. 1,100 lamps added during the past year. Station cost £40,000. 6d. per B.T.U.; discounts for large consumers; gas 2s. 6d. per 1,000 feet. Coal and liquid fuel used for stoking. Manager and Engineer, G. F. Metzger, 7, Dorchester Street, Bath.

BEDFORD.—Corporation. High pressure alternating current. 3 Belliss engines, 3 Kapp alternators, 80 kw. each. 4 Babcock and Wilcox boilers. 2 Allens engines, 2 Siemens alternators, 90 kw. each. Sub-stations and distribution on 3-wire system. Capacity of station, 9,000 8-C.P. lamps, about 6,000 wired, including public lamps. Price per unit, 6d.; gas, 3s. Engineer,

BELFAST.—Corporation. Low tension three-wire with accumulators. 6 Siemens dynamos, rope driven from horizontal gas engines by Dick Kerr, and two dynamos direct driven from high-speed Acme engines. Bare copper mains in concrete culverts, and cable in cast-iron pipes. Capacity of works, 7,500 8-C.P. at one time with spare; 2 engines being erected which will increase capacity 50 per cent. Gas at 2s. 3d. per 1,000 used for gas engines. 7d. per unit, less discounts from 2½ to 17½ per cent.; 4d. per unit, less same discounts, for daylight hours and motors. Gas, 2s. 9d., with discounts, making it equivalent to 2s. 3d. Revenue per 8-C.P. lamp, 6s. 10d. Cost of constructing and equipping works up to end of 1895, £29,000. Engineer-in-Chief, Victor A. H. McCowen.

BIRMINGHAM.—Birmingham Electric Supply Company, Limited. L.T. system. Willans engines, Lancashire boilers (1,400 H.P.), and Crompton dynamos. Underground mains, feeders consisting of copper strip in culvert, on Crompton system; distributing mains on Callender's solid system. No street lighting; 18,200 16-C.P., or equivalent for private lighting. 6,050 16-C.P. lamps added during the past 12 months. Capacity of station, 25,000 16-C.P. lamps. Price per unit, 7d., with sliding scale; gas 2s. 10d. Engineer, J. C. Vaudrey, 14, Dale End, Birmingham.

BLACKBURN.—Corporation. L.T. continuous current three-wire, 230 volts, and H.T. alternating (2,000 volts) for outside districts. 3 Lanc. boilers, 6 Willans engines, aggregating 640 H.P. Siemens continuous

CHAGFORD.—The Chagford and Devon Electric Light Co., Ltd. H.T. alternating system with Hedgehog transformers. High breast water wheels, 50 H.P. Siemens dynamos. Underground mains, lead covered, paraffin paper insulation. 550 8-C.P. for private lighting, 14 32-C.P. for outdoor lighting. A charge of 10s. per 8 C.P. per annum is made; gas, 5s. 10d. Station cost £2,000. Engineer, George H. Reed, The Factory, Chagford.

CHATHAM.—Chatham, Rochester, and District Electric Lighting Company. H.T. alternating system with house transformers. 3 Babcock and Wilcox boilers, 1 Robey and 2 Marshall's engines, 2 Ferranti dynamos, and 2 Brush arc machines. Capacity of station, 8,600 8-C.P. lamps. Managing Director, H. Hurrell, Fair View, New Brompton, Kent.*

CHELMSFORD.—Chelmsford Electric Light Company, Limited. H.T. alternating and continuous current arc lighting. Multi-Lancashire and Paxman boilers, 3 Willans engines, 120 H.P., Crompton dynamos. Overhead and underground mains. 20 arcs, and 250 32-C.P. for street lighting. 2,600 8-C.P. for private lighting. 700 lamps added during past twelve months. Price per unit, 6¾d. (sliding scale); gas, 4s. 6d. Engineer, H. B. Price, Arc Works, Chelmsford. (These works were partially destroyed by fire in November last and are being reconstructed.)*

CHELTENHAM.—Corporation. H.T. alternate current, with transformer sub-stations. 2 Galloway boilers working in parallel during the day with an ash destructor boiler; 1 200 H.P. Willans engine and 2 80 H.P. Willans driving direct 3 Siemens alternators, 2 of 30 kw. and 1 of 100 kw. In principal streets, unarmoured concentric cables in pipes, otherwise armoured concentric cables. 2 arcs used for streets, and 12 arcs and 6,000 incandescent lamps used for private lighting. Price charged for lighting, 6d. to 3½d. by scale of rebates; for power, 3d.; gas, 2s. 4d. Preliminary works cost £16,800. It is expected that considerable economy will be effected by the use of ash destructor boiler. Engineer-in-Chief, Hamilton Kilgour, Electric Works, Cheltenham.

COATBRIDGE.—Scottish House-to-House Electricity Supply. H.T. alternating current. Mordey alternators driven by Dick, Kerr & Co.'s gas engines.

COVENTRY.—Corporation. H.T. alternating. 2 Lanc. boilers, 30 × 7 ft. 6 in., 140 lbs. pressure. One 100 H.P., and one 200 H.P. horizontal engines by Fowler, driving "Leeds and London" alternators by ropes. India-rubber cables drawn into iron pipes for high tension, and concentric armoured cables laid direct in ground for low tension. Equivalent of 9,000 8-C.P. lamps connected. Capacity of works, 5,000 8-C.P. lamps. Price per unit, 6d. for first two hours, 3½d. afterwards, on Brighton system; gas, 2s. 6d. to 2s. 7d. Total cost of constructing and equipping central station and laying of mains, £22,000. Engineer, G. S. Ram.

COWPEN QUAY.—Sanderson & Co. Brush arc lamps in series. Babcock boiler, Chandler engine. Overhead wires with fluid insulation. 19 arcs of 2,000 C.P., used for harbour lighting. Engineer, R. S. Mylton. No further information.*

DERBY.—Corporation. H.T. alternating current sub-station system with ring main secondary for private supply, constant current arc for street lighting. 6 Lancashire boilers with Galloway tubes. Siemens alternators and arc lighters coupled direct to Browett & Lindley engines. Underground armoured feeder mains, vulcanised mains for distributing in earthenware conduits. Large waterwheel, 100 H.P. Turbine, 30 H.P. Steam engine, 50 H.P. About 1,100 8-C.P. lamps connected for private lighting. 1,200 8-C.P. lamps being wired for at present. No public lighting. Capacity of station, 3,000 8-C.P. Price per unit, 6d.; gas, 5s. Annual revenue per 8-C.P. lamp, 9s. Contract price, 9s. 3d. per 8-C.P. lamp per annum. Engineer, W. H. Joyce.

DEWSBURY.—Corporation. Low-pressure three-wire, with accumulators. Lancashire boilers, Willans engines, total I.H.P. about 550; feeders, concentric armoured, distributing non-concentric, armoured. Capacity of station 6,900 8-C.P. lamps. Electrical Engineer, J. B. Mitchell, Bradford Road, Dewsbury.

DOVER.—Dover Electricity Supply Company, Limited. High-pressure alternating system with transformer sub-stations under streets, supplying low tension distributing mains. Babcock and Wilcox boilers, Vertical compound engines 550 H.P.; Mordey alternators. High-pressure cables are Silvertown concentric, low-pressure B.I.W. concentric drawn into cast iron pipes. 31 arcs used for street lighting. Nearly 4,800 8-C.P. lamps applied for private lighting. Capacity of station 11,000 8-C.P. lamps. 7d. and 5d. per unit; gas, 2s. 6d. Cost of constructing and equipping station, £48,000. Consulting Engineer, A. J. Lawson, Moorgate Court, E.C.; Resident Engineer, A. A. Whitlock, Park Street, Dover; Secretary, F. E. Beeton, Park Street, Dover.

DUBLIN.—Corporation. High tension alternating (2,000 v.), with house transformers, for private supply; 3,000 v. arc circuits for public lighting. 4 Babcock boilers; 2 dry-back marine-Lanc. boilers, 200 H.P. each; 3 compound engines of 350 H.P. each, 1 of 100 H.P., 1 400 H.P. horizontal compound engine driving by ropes; 3 compound engines of 60 H.P. each, for

KESWICK.—Keswick Electric Lighting Company. H.T. alternating transformer system. Victor turbines, 50 H.P., and the Westinghouse engine, 50 H.P. Kapp alternator. Overhead wires on Johnson & Phillips fluid insulator. 1 arc lamp and 1,048 incandescent lamps for private supply. Capacity of station, 2,000 8-C.P. lamps. Price to consumers is by contracts based on gas bills; gas, 3s. 3d. per C.P. per annum. Engineer, J. R. Dixon, Stanley Terrace, Blencathra Road, St. Keswick.*

KEYNSHAM.—Town and Village Electric Lighting Company. Street lighting on series system (Parfitt's). System extends to Kingswood.

KILLARNEY (IRELAND).—Lighting done by company. H.T. alternating (2,000 v.) transformers in sub-stations. Vulcanised cables in earthenware conduits. Large waterwheel, 100 H.P. Turbine, 30 H.P. Steam engine, 50 H.P. About 1,100 8-C.P. lamps connected for private lighting. 1,200 8-C.P. lamps being wired for at present. No public lighting. Capacity of station, 3,000 8-C.P. Price per unit, 6d.; gas, 5s. Annual revenue per 8-C.P. lamp, 9s. Contract price, 9s. 3d. per 8-C.P. lamp per annum. Engineer, W. H. Joyce.

KINGSTON-UPON-THAMES.—Corporation. High tension alternating (2,000 v.), with transformer sub-stations. Belliss engines and boilers, Siemens dynamos. Underground mains, Siemens concentric armoured cable. 36 arc lamps, used for streets; 12 arcs and 5,000 incandescents, for private supply. Capacity of station, 9,000 8-C.P. Price per unit, 6d., reduced to 4d., after average of two hours burning, on Wright's system; gas, 2s. 11d. Cost of station about £23,700; mains, £5,300. For 1895 the works cost per unit was 4·745d. The annual revenue per 8-C.P. lamp for 1895 was 8s. 8d. Engineer, J. E. Edgcome, Electric Light Station, Kingston-upon-Thames.

KINGSTON-UPON-HULL.—Corporation. L.T. three-wire system, with accumulators. Willans engines, 2 80-H.P., 2 200-H.P., and 2 300-H.P., combined with Siemens and Holmes dynamos. 3 200-H.P. "Economic" boilers, and 1 300-H.P. boiler. Underground mains, on Crompton bare copper strip and Callender-Webber systems. Equivalent to 21,600 8-C.P. lamps connected. Capacity of station, 20,000 8-C.P. lamps. Prices per B.T. unit, 5½d. for lighting purposes, 4d. purposes other than lighting. Gas (two companies serving within present area of supply) prices, 1s. 10d. and 3s. respectively. Capital expended to December 31st, 1895, £45,429. No public lighting. Immediate extensions are contemplated. Borough Electrical Engineer, A. S. Barnard, Electric Light Station, Dagger Lane, Hull.

LANCASTER.—Corporation. L.T. 3-wire system, with accumulators. 2 Lanc. boilers, 3 Willans compound engines, aggregate 395 I.H.P. Underground mains on Callender-Webber system. 14 arc lamps placed in the street. 3,400 16-C.P. used in private lighting. Capacity of station, 4,000 16-C.P. Price per unit, 5d., 4d. motive power and public lighting; gas, 2s. 6d. Cost of station, including mains, £21,367 (to December 31st, 1895). Total works' cost, 2·97d. per unit. Revenue per 8-C.P., 6s. 2d. Engineer, C. M. Johnson, Town Hall, Lancaster.

LARNE (CO. ANTRIM).—Larne Electric Light Works, Limited. High tension alternating system with sub-station transformers and street transformers. 2 horizontal engines 100 I.H.P. each. 2 25-k.w. Mordey alternators (2,000 v.). 2 Cornish boilers. High tension mains (British insulated concentric) are placed underground; part of low tension network overhead supplied from transformers on poles. Streets lighted by 11 arc lamps and 80 incandescents. Private lighting 800 8-C.P. lamps. Capacity of station about 1,500 8-C.P. Price per unit, 8d., though much of the lighting is done on a contract of £1 per 16 C.P. lamp per annum; gas, 4s. 2d. Resident engineer, Mr. G. Smyth.

LEAMINGTON.—Midland Electric Light Company. Low tension 2-wire system. Robey engines and Chamberlain & Hookham dynamos. Number of 8-C.P. lamps, 5,500. Capacity of station, 10,000. Meters used, Hookham exclusively. Battery of 72 cells K-33 E.P.S. put down 1895. Revenue per 8-C.P. lamp, 1895, 5·32s. Average price obtained 6·56d. Engineer and manager, F. W. E. Jones.

LEEDS.—Yorkshire House-to-House Electricity Company, Limited. High tension alternating with house transformers. 6 Lanc. boilers, 30 ft. × 8 ft., 4 Fowler engines, 2 Hick, Hargreaves & Co.'s engines (total I.H.P., 1,800), 3 E.C.C. alternators, 3 Hall alternators. Underground mains, Silvertown cables laid in cast-iron pipes. Private supply consists of about 33,000 8-C.P. lamps. Price 6d. per unit, subject to discounts of 15 per cent. and 5 per cent. Works' costs—Coal, 3d.; oil waste, water, and stores, ·16d.; salaries, engineer's wages, ·81d.; repairs, ·19d.—1·46d. Revenue per 8-C.P. lamp, 8s. Gas, 2s. 4d. Cost of station, £76,526. Resident engineer, H. Dickinson.

LONDON DISTRICTS *(continued)*:—

KENSINGTON.—Kensington and Knightsbridge Electric Light Company, Limited. 2 stations, Kensington Court, W., and Chapel Place, S.W. L.T. 3-wire system, with secondary batteries. Babcock boilers, 2,660 H.P., Willans engines, 2,730 H.P. Siemens and Crompton dynamos. Underground mains, copper strip in culvert, and Henley's cable in iron pipes. 94,780 8-C.P. lamps connected for private lighting. 14,102 8-C.P. incandescents added during the past 12 months. Capacity of stations, 53,000, 8-C.P. lamps on at one time (without batteries). Price per unit, 6d. Works' costs 1·89d. Revenue per lamp, 6s. 7d. Lamps connected up to March 11th, 1896, 98,413. Engineer-in-Chief, R. E. Crompton, "Thriplands," Kensington Court, W. Engineers, H. W. Miller, at Kensington Court; C. J. Barley, at Chapel Place.

LONDON Electric Supply Corporation. H.T. alternating (10,000 v.) with transformer sub-stations. Plenty & Son and Hick, Hargreaves engines and Ferranti alternators. Underground concentric mains. About 100,000 8-C.P. lamps connected. General Manager, R. Stewart Bain, C.A. Engineer, P. W. D'Alton.

ST. JAMES'S PARISH.—St. James's and Pall Mall Electric Lighting Company, Limited. L.T. three-wire. Two stations, in which are Davey-Paxman boilers, Willans engines, and dynamos by Siemens and Latimer Clark, Muirhead. Underground mains, bare copper strip and armoured cables. 91,786 8-C.P. lamps for private supply. 16,569 8-C.P. added during the past year. Capacity of stations, 78,000 8-C.P. lamps Price per unit, 6d., with rebate; gas, 3s. 1d. Works' cost 1·93d. per unit. Revenue per lamp, 10s. Engineer-in-Chief, S. T. Dobson, Carnaby Street Station, Golden Square, W.

ST. MARTIN'S-IN-THE-FIELDS.—Charing Cross and Strand Electricity Supply Corporation, Limited. L.T. direct current system. Babcock boilers, McPhail & Simpson's superheaters, Willans engines, and Mather and Platt and Siemens dynamos. Crompton-Howell batteries. Underground mains on Callender system. 45 arc lamps, and 53,000 8-C.P. incandescents used for private lighting. 9,000 lamps added during the past 12 months. Price per unit is 6d. reducible to 5d. Works' cost per unit 1·94; total, 3·21d. Revenue per 8-C.P. lamp 12s. Engineer-in-Chief, W. H. Patchell, 12, Maiden Lane, W.C.

ST. MARY ABBOTS, KENSINGTON.—House-to-House Electric Light Supply Company, Limited. Alternating current system with sub-stations. 5 Fowler's engines, each 180 I.H.P., and 1 of 100 I.H.P. 4 Babcock, 2 Lanc., and 2 Niclausse boilers. 5 Elwell-Parker dynamos, 2 250 H.P. and 1 150 H.P. Willans-Electric Construction Combination. Lamps connected to Dec. 31st, 1895, 44,162 35-watt; lamps connected during year, 8,304 35-watt. Capacity of station, 930 kilowatts. Price per unit (from March 25th, 1896), 6d. Total cost of works, mains, &c. (capital expenditure), to Dec., 1895, £102,380 8s. 7d. Manager and Engineer, Henry W. Bowden, Richmond Road, Earls Court, S.W.

ST. PANCRAS PARISH.—Vestry. L.T. continuous three and five-wire system and accumulators. Babcock boilers, Willans engines, 1,660-I.H.P., and Latimer Clark & Co. and Kapp multipolar dynamos. Underground mains, bare copper strip, in culvert, and armoured cables, 98 arcs, two 50 C.P. incandescent for street lighting; 139 arcs and 19,155 incandescent lamps of 16 C.P., and 37 motors used for private purposes. Present capacity of station, 30,000 64-watt lamps. Price per unit, 6d., 3d. for "day" supply; gas 2s. 11d. A second central station, in connection with a refuse destructor works, has recently been opened in the King's Road, Camden Town, giving a house service of 200 volts.

STRAND DISTRICT, ST. MARTIN'S, HOLBORN, MARYLEBONE, PADDINGTON.—Metropolitan Electricity Supply Company, Limited. H.T. alternating transformer system and low pressure continuous system. There are five stations, at the following places: Manchester Square, Sardinia Street, Rathbone Place, Amberley Road, Paddington, and at Whitehall Avenue. Babcock and Wilcox and Hick, Hargreaves boilers; engines by Parsons, Willans, Hornsby, and Allen; dynamos by Electric Construction, Kapp, Siemens, Parsons, British Thomson-Houston, and Latimer Clark, Muirhead & Co. Private lighting is equivalent to 270,000 8-C.P. Price per unit, 7½d., with sliding scale to 5½d. Engineer-in-Chief, Frank Bailey, 17, South Street, Manchester Square, W.

WANDSWORTH.—County of London and Brush Provincial Electric Lighting Company, Limited. H.T. alternating current system, with high and extra high pressure feeders, with transformer boxes under streets, supplying current to low tension mains at a pressure of 200 volts. High pressure 2,000 volts, extra high pressure 5,000 volts. Babcock-Wilcox boilers. Vertical compound engines (1,500 H.P.) direct coupled to Mordey alternators. Silvertown concentric cables sheathed with steel tape for high and extra high tension. Callender's concentric cables drawn into cast-iron pipes for low tension. Price per unit, 7d., 5d. for power, heating, &c. Engineer-in-Chief, A. J. Lawson, Moorgate E.C. Works are in course of construction.

LYNMOUTH.—The Lynton and Lynmouth Electric Light Company, Limited. H.T. alternating current system. Water power; Little Giant turbine and Pelton wheels. Lowrie-Hall and Mordey alternators. Street

PRESCOT.—British Insulated Wire Company. H.T. alternating current system. 2 Lanc. boilers. 2 Mordey and 2 Ferranti alternators; 2 Raworth and 2 Browett & Lindley engines. Underground mains on B.I.W. system. 15 2,000-C.P. arcs and 96 16-C.P. incandescent for street lighting, about 2,300 8-C.P. for private lighting. Capacity of station, 2,600. Price per unit, 6d., with discount to 3d.; gas, 4s. 6d. Annual revenue per 8-C.P. lamp, 11s. Engineer-in-chief, G. H. Nisbett.

PRESTON.—National Electric Light Company. L.T. 3-wire system. Belliss direct coupled engines, 2 of 60 H.P., and 8 of 110 I.H.P., 5 Lancashire multitubular boilers of 250 H.P. each, by Penman & Co., dynamos by Latimer Clark, Muirhead & Co. Underground mains. 12 arcs and 26 32-C.P. incandescent lamps for street lighting, and 15,000 lamps of 8-C.P. for private lighting. Present capacity of station 24,000 8-C.P. connected at once. Price 7d. and 4d., on Wright's system, less 15 per cent. for cash in each case; gas, 3s. 7½d., less 15 per cent. Works' cost per unit delivered, 1·47d. Revenue (current only) per 8-C.P. lamp, 8s. 9d. Engineer, J. H. Tonge, 20, Bairstow Street, Preston.

READING.—Reading Electric Supply Company, Limited. H.T. alternating, 380 kwts., 6,000 30-watt lamps. Price per unit, 6d.; gas 3s. Engineer, F. F. Yeatman.

RICHMOND (Surrey).—Richmond Electric Light and Power Company, Limited. Low pressure 3-wire system with accumulators. 3 200-H.P. Lanc. boilers by Penman & Co., 5 high-speed engines aggregating 400 H.P. Latimer Clark, Muirhead dynamos. Bare copper strip mains in iron culverts and armoured cables. No street lighting, 16 arc lamps and 5,700 8-C.P. lamps used for private lighting. Price per unit, 7d.; gas, 3s. 1d. Resident Engineer, Malcolm C. Flemyng.

SALFORD.—Corporation. H.T. alternating current, with sub-stations and house transformers. 3 compound horizontal engines of Corliss type by Browett, Lindley & Co., 675 H.P., driving by ropes Mather & Platt alternators. Concentric mains for high tension, and triple concentric mains for low tension. Lamps connected for private lighting equivalent to 8,000 8-C.P. Capacity of works, 15,000 8-C.P. 7d. per unit; gas, 2s. 4d. Gas coke used for boilers. Cost of constructing works, £40,000. Engineer-in-Chief, Chas. L. Turner, Electricity Works, Wallness Road, Broughton, Manchester.

SCARBOROUGH.—Scarborough Electric Light Company, Limited. H.T. alternating (2,000 v.) system, with street box transformers in part of the town. 3 Lanc. boilers, 3 160-kw. and 1 75-kw. Parsons steam turbine alternators and exciters. 30 arcs and 12,492 8-C.P. incandescent lamps for houses. Underground mains consisting of India-rubber non-concentric cables drawn into cast-iron pipes. Capacity of station, 17,500 30-watt lamps. Price per unit, 6¾d. to 5½d. according to consumption; gas 3s., with discount of 3d. Managing Director and Engineer-in-chief, A. A. C. Swinton, 66, Victoria Street, Westminster. Resident Engineer, G. S. Peck, 102, Westborough, Scarborough.

SHEFFIELD.—Sheffield Electric Light and Power Company, Limited. H.T. alternating system with transformer sub-stations. 6 engines, 1,600 H.P., 6 boilers, 2,100 H.P., 28,000 8-C.P. lamps. Present capacity of station, 30,000 8-C.P. lamps. Price per unit, 6d.; price of gas, 2s. Works' cost per unit, 2·29d. Annual revenue per 8-C.P. lamp, 5s. 6d. Manager and Secretary, Wm. Johnson, M.I.E.E.

SHREWSBURY.—Shropshire Electric Light and Power Company, Limited. L.T. three-wire. 3 60 H.P. Babcock boilers, 3 50 H.P. Bellis engines, driving 3 Parker dynamos. Armoured concentric cables for feeders, and 3-core Callender armoured cables for distribution. 1,300 8-C.P. lamps and 9 arc lamps for private lighting. Capacity of works, 3,000 8-C.P. lamps. 7d. and 6d. per unit; gas, 3s. Cost of constructing and equipping works, £13,000. Engineer-in-Chief, Mr. Cuthbert, Wigham.

SOUTHAMPTON.—Southampton Electric Light and Power Company, Limited. Low tension three-wire with accumulators. 2 Willans 100 I.H.P. engines, 1 Willans 60 I.H.P. engine, 1 Belliss 136 I.H.P. engine, high speed, 1 Robey 120 I.H.P. engine, slow speed, all driving Crompton dynamos. Underground mains on Crompton system. 70 arcs (private) of various sizes. Lamps connected 5,000 8-C.P., including arcs, but excluding cranes, approximately 1,500 8-C.P. Capacity of station, 8,000 8-C.P., with all plant in use (including crane plant). Price, 7d., with sliding scale; power, 6d.; gas, 2s. 3d. Cost of station and mains approximately, £19,000. Revenue per 8-C.P. in 1895, 9s. 6d. Works' cost in 1895, 3·2d. per unit sold. The business is to be taken over by the Corporation after the 31st inst. Engineer, J. H. Lee, Central Electric Light Station, Back of the Walls, Southampton.

SOUTHPORT.—Corporation. H.T. alternating (2,000 v.) system, with sub-stations. 2 Lancashire boilers, 3 Browett & Lindley engines and Mather and Platt alternators, rope driven, of 160 kilowatts capacity. Underground mains, concentric armoured cables. The boilers are constructed for burning coke breeze from the Corporation Gas Works. 20 arcs and 4,000 8-C.P. for private lighting. Cost per unit, 7d.; gas, 3s. Works have cost to [illegible]

stations and L.T. network, 2 200 H.P. Marshall compound condensing engines, combined with Siemens fly-wheel alternators running at 95 revolutions, 2 25 H.P. Belliss engines for exciters, and 1 50 H.P. Belliss engine for 25 kw. alternator. Callender's mains in cast-iron pipes for high tension, and armoured cables for low tension. 25 arcs for street lighting. Capacity of works, 7,000 8-C.P. Price of gas from 3s. 9d to 4s. 2d. Cost of works, including 3,000 yards extension mains, £21,000. Engineer-in-Chief, Ernest G. Pink.

BATH.—Bath Electric Lighting Company. H.T. alternating system. Thomson-Houston machines for street lighting. Brush Company alternators for private supply. Babcock boilers, Raworth and Browett-Lindley engines. 84 arcs for street lighting, 10 arcs and 11,281 8-C.P. incandescent for private lighting; capacity of station, 10,000 incandescent and 200 arcs. Callender underground mains. 1,100 lamps added during the past year. Station cost £40,000. 6d. per B.T.U.; discounts for large consumers; gas 2s. 6d. per 1,000 feet. Coal and liquid fuel used for stoking. Manager and Engineer, G. F. Metzger, 7, Dorchester Street, Bath.

BEDFORD.—Corporation. High pressure alternating current. 3 Belliss engines, 3 Kapp alternators, 30 kw. each. 4 Babcock and Wilcox boilers. 2 Allens engines, 2 Siemens alternators, 90 kw. each. Sub-stations and distribution on 3-wire system. Capacity of station, 9,000 8-C.P. lamps, about 6,000 wired, including public lamps. Price per unit, 6d.; gas, 3s. Engineer,

BELFAST.—Corporation. Low tension three-wire with accumulators. 6 Siemens dynamos, rope driven from horizontal gas engines by Dick Kerr, and two dynamos direct driven from high-speed Acme engines. Bare copper mains in concrete culverts, and cable in cast-iron pipes. Capacity of works, 7,500 8-C.P. at one time with spare; 2 engines being erected which will increase capacity 50 per cent. Gas at 2s. 3d. per 1,000 used for gas engines. 7d. per unit, less discounts from 2½ to 17½ per cent.; 4d. per unit, less same discounts, for daylight hours and motors. Gas, 2s. 9d., with discounts, making it equivalent to 2s. 6d. Revenue per 8-C.P. lamp, 6s. 10d. Cost of constructing and equipping works up to end of 1895, £29,000. Engineer-in-Chief, Victor A. H. McCowen.

BIRMINGHAM.—Birmingham Electric Supply Company, Limited. L.T. system. Willans engines, Lancashire boilers (1,400 H.P.), and Crompton dynamos. Underground mains, feeders consisting of copper strip in culvert, on Crompton system; distributing mains on Callender's solid system. No street lighting; 18,200 16-C.P., or equivalent for private lighting. 6,050 16-C.P. lamps added during the past 12 months. Capacity of station, 25,000 16-C.P. lamps. Price per unit, 7d., with sliding scale; gas 2s. 10d. Engineer, J. C. Vaudrey, 14, Dale End, Birmingham.

BLACKBURN.—Corporation. L.T. continuous current three-wire, 250 volts, and H.T., alternating (2,000 volts) for outside districts. 3 Lanc. boilers, 6 Willans engines, aggregating 640 H.P. Siemens continuous current machines, and Siemens alternators, and a battery of E.P.S. accumulators. Armoured concentric Diatrine cables laid direct in the ground for high tension; India-rubber cables in cast-iron culverts for low tension. 18 arcs of 12 amperes for street lighting, and 50 arcs and 5,700 8-C.P. incandescents for private lighting. Capacity of works, 17,000 8-C.P. lamps. Price per unit, 6d. for lighting and 4d. for power and heating. Gas, 3s. 7d. for lighting and 2s. 9d. for stoves and gas engines. Total cost of constructing and equipping works, £32,000. Engineer, Alfred S. Giles, Corporation Electricity Works, Blackburn.

BLACKPOOL.—Corporation. H.T. alternating (2,000 v.) for private supply. Series arcs for public lighting. Fowler engines, Lowrie-Hall alternators, Brush arc machines. Maximum demand, 590 kw. for private lighting. 130 arc lamps for street. Price per unit, 6d.; gas, 2s. 4d. Station, with extensions, cost £50,000; mains, £7,900. 300 kw. at present on order for extension. Capacity of station, 500 kw. alternating, 90 kw. arcs. Engineer, John Hesketh. (Mr. Hesketh will shortly resign, new engineer not yet appointed.)

BOLTON.—Corporation. H.T. alternating with sub-stations. L.T. network on three-wire system. House transformers in outlying districts. 3 Lancashire boilers, 3 engines of Messrs. J. & E. Wood, driving 3 Mordey alternators by ropes. 1 engine of Messrs. Hick, Hargreaves & Co., direct coupled to Ferranti alternator; H.T. concentric vulcanised rubber in iron pipes, and also concentric paper insulated armoured-laid direct; L.T. Siemens triple core armoured cable. Price per unit, 6d., less 10 per cent. for cash in 21 days, and also 2½ per cent. on every 250 units per quarter; gas, 2s. 6d. nett. Coke breeze used in daytime, and mixed with slack coal at night. Capital outlay, £33,500. About 9,500 8-C.P. connected. Works' cost (1895, first year, 83,990 units) = 3·02d; fuel = ·55d. Engineer, J. H. Rider, Spa Road, Bolton. (Mr. Rider has resigned, Mr. Arthur Ellis has been appointed.)

Now erecting.—Fourth boiler; another Hick, Hargreaves-Ferranti combined plant; 2 miles mains; motor alternator for light loads.

BOURNEMOUTH.—Bournemouth and District Electric Supply Company. H.T. alternating current. Mordey-Victoria alternators and Brush engines, of 1,250 I.H.P., Babcock boilers 1,250 H.P. Mains, buried armoured cables and rubber cables drawn into cast-iron pipes. 20,567 8-C.P. incandescent lamps, wired for private supply. 1,797 lamps added during 1895. Capacity of station, 16,500 8-C.P. lamps used simultaneously. Price per unit, 7d.; gas, 3s. 6d. Annual revenue per 8 C.P., about 7s. 6d. Works' cost 3·66d. per unit sold 1895. Engineer, H. M. Sayers, Verulam House, Yelverton Road, Bournemouth.

BRADFORD.—Corporation. Low tension three-wire system with batteries. Lowest pressure, 230 volts; highest, 460 volts. 11 Siemens dynamos, Willans engines; 5 Lanc. boilers, 2 marine induced draught boilers; armoured cable (underground). About 40,000 8-C.P. lamps connected for private lighting. No public lighting. Price per unit, 5d. for light; 3½d. for motive power. Price of gas, 2s. 8d. Works' cost per unit, 1·57d. Annual revenue per 8-C.P. lamp, 6s. 10d. Engineer-in-Chief, Alfred H. Gibbings, Town Hall, Bradford.

BRAY (IRELAND).—Bray Township Commissioners. High tension alternating system (1,000 volts), with two wire low-tension distribution from transformer sub-stations. Brush Falcon 120 H.P. engine; Davey-Paxman 40 H.P. loco. boiler; 2 Victor turbines 40 H.P.; 30 arc lamps, and 108 incandescent lamps of 25 C.P. for street lighting; private lighting equivalent to 1,230 8-C.P. Price per unit, 8d., or by contract. Present capacity of station in 8 C.P., 3,500. 384 lamps added during past year. Price of gas, 4s. 9d. Annual revenue per 8-C.P. lamp, 10s. 1d. The Commissioners purchased the station for £3,060, on January 1st, 1896. Resident Engineer, G. Marshall Harris, Bray Mills, Ireland.

BRIDLINGTON.—Municipal Authority. Thomson-Houston arc-lighter. Motive power hired from sawmill. 18 arcs of 1,200 C.P. each Lamps run during summer season. Engineer, R. Railton Brown.*

alternating current. Mordey alternators driven by Dick, Kerr & Co.'s gas engines.

COVENTRY.—Corporation. H.T. alternating. 2 Lanc. boilers, 30 × 7 ft. 6 in., 140 lbs. pressure. One 100 H.P., and one 200 H.P. horizontal engines by Fowler, driving "Leeds and London" alternators by ropes. India-rubber cables drawn into iron pipes for high tension, and concentric armoured cables laid direct in ground for low tension. Equivalent of 3,000 8-C.P. lamps connected. Capacity of works, 5,000 8-C.P. lamps. Price per unit, 6d. for first two hours, 3½d. afterwards, on Brighton system; gas, 2s. 5d. to 2s. 7d. Total cost of constructing and equipping central station and laying of mains, £22,000. Engineer, G. S. Ram.

COWPEN QUAY.—Sanderson & Co. Brush arc lamps in series. Babcock boiler, Chandler engine. Overhead wires with fluid insulation. 19 arcs of 2,000 C.P., used for harbour lighting. Engineer, R. S. Mylton. No further information.*

DERBY.—Corporation. H.T. alternating current sub-station system with ring main secondary for private supply, constant current arc for street lighting. 6 Lancashire boilers with Galloway tubes. Siemens alternators and arc lighters coupled direct to Browett & Lindley engines. Underground armoured feeder mains, vulcanised mains for distributing in earthenware pipes. 14,000 8-C.P. lamps for private lighting, 77 arcs for streets. Capacity of station, 18,000 lamps of 8-C.P. Price per unit, 6d.; 3d. for power, cooking, &c.; gas, 2s. 8d. Engineer-in-Chief, J. E. Stewart, A.M.Inst.C.E. and E.E.

DEWSBURY.—Corporation. Low-pressure three-wire, with accumulators. Lancashire boilers, Willans engines, total I.H.P. about 550; feeders, concentric armoured, distributing non-concentric, armoured. Capacity of station 6,900 8-C.P. lamps. Electrical Engineer, J. B. Mitchell, Bradford Road, Dewsbury.

DOVER.—Dover Electricity Supply Company, Limited. High-pressure alternating system with transformer sub-stations under streets, supplying low tension distributing mains. Babcock and Wilcox boilers, Vertical compound engines 550 H.P.; Mordey alternators. High-pressure cables are Silvertown concentric, low-pressure B.I.W. concentric drawn into cast iron pipes. 31 arcs used for street lighting. Nearly 4,800 8-C.P. lamps applied for private lighting. Capacity of station 11,000 8-C.P. lamps. 7d. and 5d. per unit; gas, 2s. 6d. Cost of constructing and equipping station, £48,000. Consulting Engineer, A. J. Lawson, Moorgate Court, E.C.; Resident Engineer, A. A. Whitlock, Park Street, Dover; Secretary, F. E. Beeton, Park Street, Dover.

DUBLIN.—Corporation. High tension alternating (2,000 v.), with house transformers, for private supply; 3,000 v. arc circuits for public lighting. 4 Babcock boilers; 2 dry-back marine-Lanc. boilers, 200 H.P. each; 3 compound engines of 350 H.P. each, 1 of 100 H.P., 1 400 H.P. horizontal compound engine driving by ropes; 3 compound engines of 60 H.P. each, for public lighting. Lowrie-Hall alternators, Brush arc machines, Silvertown cable in underground pipes. 81 500-watt arc lamps for streets; 21 arcs, and 15,000 8-C.P. incandescent lamps for houses. Gas, 3s. 4d. The station cost £31,000. Additions and mains, £20,000. Total, £51,000. Engineer, Mark Ruddle, Central Station, Dublin.

DUNDEE.—Corporation. L.T. 3-wire system with accumulators. 3 Lancashire boilers, 7 Willans engines, and 7 continuous current dynamos by Siemens. A battery of accumulators with an output of 350 amperes for one hour. Total lamps connected equivalent to 17,000 8-C.P. 5d. per unit; gas, 3s. 4d., less 5 per cent. Cost of feeders and mains (exclusive of service mains) £6,590. Cost of constructing and equipping central station, £30,000. Engineer, Walter H. Brownlee, 1, Blackness Crescent, Dundee.

EALING.—(*See* **LONDON DISTRICTS.**)

EASTBOURNE.—Eastbourne Electric Light Company. H.T., alternating system, with house transformers; series system for arc lighting. Fowler's and Marshall's engines; Fowler's and Davey-Paxman boilers; total engine H.P. 650. Lowrie-Parker alternators. Cables drawn into cast-iron pipes. 96 arc lamps, used for street lighting; 14,409 8-C.P. lamps for private lighting. Price per unit, 8½d. and discounts; gas, 3s. 2d. Engineer, H. W. Wilkinson, Central Station, Eastbourne.

EDINBURGH.—Corporation. H.T. alternating and L.T. continuous. Dry-back marine type boilers, Willans engines of 1,920 H.P., direct coupled to Siemens continuous current dynamos and Ferranti alternators. Concentric paper covered mains for high tension, three-wire with feeders and batteries for low tension. Feeders bare copper strip in culverts and armoured cable, distributing mains rubber covered. Street arc lighting partly done from L.T. mains, 4 arcs in series, and partly by H.T. series lighting current rectified by Ferranti rectifiers, 247 arcs. 50,000 8-C.P. connected for private lighting. 6d. per unit, with rebate; 3½d. for power; gas, 3s. Cost of constructing and equipping works, including mains, £130,000. Engineer-in-Chief, F. A. Newington.

EXETER.—Exeter Electric Light Company. H.T. alternating and H.T. series arc. Two compound horizontal, non-condensing engines, 120 H.P. each, and 1 80-H.P. by Fowler, and two Westinghouse triple expansion engines of 25 H.P. 3 Babcock boilers, 150-H.P. each. Underground mains, Fowler-Waring concentric cable. 21 arcs and 7,000 8-C.P. for private lighting. Capacity of station, 6,600 8-C.P., and 60 arc lamps; 1,000 lamps added during the past year. Price per unit. 6d. with rebate; price of gas, 3s. Cost of station, £11,000. Cost of mains, £8,000. Works' costs per unit, 3·78d.; total costs per unit, 4·44d. Revenue per 8-C.P. lamp, 7s. 6d. (on average of lamps for year). Engineer, H. D. Munro, Rockfield Works, Exeter.

FAREHAM.—Fareham Electric Light Company. Thomson-Houston system. Ransomes, Sims & Co. compound engines. Overhead and underground mains. 20 arcs and 90 incandescent lamps for street lighting, and 320 16-C.P. incandescent lamps for private lighting. Price to consumers 1s. per C.P. per annum and 8d. per unit: gas 3s. 9d. Station, with mains, cost originally £5,000. Works just transferred to Local Authority, Fareham Urban District.

GALWAY.—Galway Electric Light Company. Low tension system. Crompton and Statter dynamos; 2 Hercules turbines. 5 arcs and 4 incandescents for docks; 2,000 8-C.P. incandescents for private lighting. Price per unit, 5d.; for power, 3d.; gas, 5s. 6d. Engineer, James Perry, M.I.C.E.

GLASGOW.—Corporation. L.T. three-wire system, with accumulators for private lighting. 3,000 v. arc machines for street lighting. Latimer Clark-Muirhead and Siemens dynamos and Willans engines, 2,600 I.H.P. 6 boilers of 300 H.P. each, by Lindsay, Burnet & Co., and 2 of 700 H.P. each, by Babcock & Wilcox. Brush machines for street lighting. Arc light mains are of rubber insulation drawn into iron pipes. L.T. network copper strip in C.I. culverts. About 112 arc lamps have been erected in the streets. 63,560 8-C.P. incandescent lamps for private lighting. Capacity of station, 40,500 8-C.P. lamps. Price per unit 6d.; gas, 2s. 4d.

combined with Siemens and Hopkinson dynamos. 3 300-H.P. Economic boilers, and 1 300-H.P. boiler. Underground mains, on Crompton bare copper strip and Callender-Webber systems. Equivalent to 21,600 8-C.P. lamps connected. Capacity of station, 20,000 8-C.P. lamps. Prices per B.T. unit, 5½d. for lighting purposes, 4d. purposes other than lighting. Gas (two companies serving within present area of supply) prices, 1s. 10d. and 3s. respectively. Capital expended to December 31st, 1895, £45,429. No public lighting. Immediate extensions are contemplated. Borough Electrical Engineer, A. S. Barnard, Electric Light Station, Dagger Lane, Hull.

LANCASTER.—Corporation. L.T. 3-wire system, with accumulators. 2 Lanc. boilers, 3 Willans compound engines, aggregate 395 I.H.P. Underground mains on Callender-Webber system. 14 arc lamps placed in the street. 3,400 16-C.P. used in private lighting. Capacity of station, 4,000 16-C.P. Price per unit, 5d., 4d. motive power and public lighting; gas, 2s. 6d. Cost of station, including mains, £21,367 (to December 31st, 1895). Total works' cost, 2·97d. per unit. Revenue per 8-C.P., 6s. 2d. Engineer, C. M. Johnson, Town Hall, Lancaster.

LARNE (CO. ANTRIM).—Larne Electric Light Works, Limited. High tension alternating system with sub-station transformers and street transformers. 2 horizontal engines 100 I.H.P. each. 2 25-k.w. Mordey alternators (2,000 v.). 2 Cornish boilers. High tension mains (British insulated concentric) are placed underground; part of low tension network overhead supplied from transformers on poles. Streets lighted by 11 arc lamps and 80 incandescents. Private lighting 800 8-C.P. lamps. Capacity of station about 1,500 8-C.P. Price per unit, 8d., though much of the lighting is done on a contract of £1 per 16 C.P. lamp per annum; gas, 4s. 2d. Resident engineer, Mr. G. Smyth.

LEAMINGTON.—Midland Electric Light Company. Low tension 2-wire system. Robey engines and Chamberlain & Hookham dynamos. Number of 8-C.P. lamps, 5,500. Capacity of station, 10,000. Meters used, Hookham exclusively. Battery of 72 cells K-33 E.P.S. put down 1895. Revenue per 8-C.P. lamp, 1895, 5·32s. Average price obtained 6·56d. Engineer and manager, F. W. E. Jones.

LEEDS.—Yorkshire House-to-House Electricity Company, Limited. High tension alternating with house transformers. 6 Lanc. boilers, 30 ft. × 8 ft., 4 Fowler engines, 2 Hick, Hargreaves & Co.'s engines (total I.H.P., 1,800), 3 E.C.C. alternators, 3 Hall alternators. Underground mains, Silvertown cables laid in cast-iron pipes. Private supply consists of about 33,000 8-C.P. lamps. Price 6d. per unit, subject to discounts of 15 per cent. and 5 per cent. Works' costs—Coal, 3d.; oil waste, water, and stores, 1·6d.; salaries, engineer's wages, 2·1d.; repairs, 1·95d.—1·46d. Revenue per 8-C.P. lamp, 8s. Gas, 2s. 4d. Cost of station, £76,526. Resident engineer, H. Dickinson.

LEICESTER.—Corporation. H.T. alternating current, with low tension distribution from street transformers. Babcock & Wilcox boilers, horizontal compound engines (1,185 H.P.), by Hick, Hargreaves & Co., Mordey fly-wheel alternators. Concentric cables in 3-in. cast-iron pipes for high tension, and concentric armoured cables laid direct in ground for low tension. 25 arcs and 10,000 8-C.P. connected. Capacity of works, 22,500. Price per unit, 6d; gas, 2s. 4d. Revenue per 8-C.P. lamp, exclusive of profit from fitting department, 4s. Total capital expended for buildings, machinery, cables, and meters, £33,709 15s. 4d. Engineer-in-Chief, Alfred Colson, M.I.C.E., Gas Offices, Leicester.

LIVERPOOL.—Liverpool Electric Supply Company, Limited. Low tension direct, partly two-wire and partly three-wire. Lanc. boilers, Willans engines (4,100 I.H.P.). Lanc. boilers, 5,760 I.H.P. Siemens and Crompton dynamos. Underground mains on Callender system. Private lighting equivalent to 39,066 16-C.P. lamps, 7,274 16-C.P. added during the past year. Capacity of stations, 37,000 16-C.P. lamps. Price per unit, 7½d.; gas 2s. 9d. Revenue per 16 C.P. lamp, 20s. for 1895. Engineer-in-Chief, A. Bromley Holmes, 15, Highfield Street, Liverpool. Business being transferred to Liverpool Corporation.

LONDONDERRY.—Corporation. H.T. continuous current system. Lancashire boilers of 400 H.P., 3 compound condensing vertical engines and 6 Siemens dynamos, constant current 10 ampères at 3,000 volts, 2 machines on each engine. Underground mains, armoured cables. Street lighting only at present, there being 170 arc lamps. Cost of constructing and equipping central station, £20,000. Engineer, J. Christie, Electric Light Station, Strand Road.

LONDON DISTRICTS:—

BELGRAVIA and PIMLICO.—Westminster Electric Supply Corporation, Eccleston Place Station. L.T. system, generated at 200 v. and distribution in two parallels of 100 volts each. Willans and Davey-Paxman engines. I.H.P. of engines, 1,750. Davey-Paxman "Economic" boilers, and Fraser of same kind. Crompton and Siemens dynamos. Underground mains, bare copper in culverts, and insulated cable in Callender conduit. Resident Engineer, C. O. Grimshaw.

MAYFAIR.—Westminster Electric Supply Corporation, Davies Street Station. Same system as at Eccleston Place. Willans engines Paxman and Fraser boilers. I.H.P. of engines, 3,000. Crompton and Elwell-Parker dynamos. Same system of mains as other stations. Engineer-in-Chief, Prof. A. B. W. Kennedy. Resident Engineer, Ll. Foster.

WESTMINSTER.—Westminster Electric Supply Corporation, Millbank Street station. Same system as other stations belonging to this company. Willans engines, Babcock boilers. Total lamp connections for the three stations of this company amount to 210,000 32-watt lamps, about 43,000 lamps have been added during 1895. Total I.H.P. of three stations 6,400. I.H.P. of engines at Millbank Street, 1,680. Works' cost per unit sold, 1·40; total cost per unit sold, 2·32. Revenue per 32-watt lamp, 7s. 2d. Including meter rents. Engineer-in-Chief, Prof. A. B. W. Kennedy. Resident Engineer, W. Robinson.

CHELSEA.—Chelsea Electricity Supply Company, Limited. System, continuous current with motor-generators and batteries, feeding into a network at 100 volts. Electric Construction dynamos, Willans engines, Babcock boilers. Underground mains on Callender-Webber system. Equivalent of 60,400 8-C.P. lamps; 10,000 added during the past year. Capacity of station, 50,000 8-C.P. lamps. Price per unit for light, 6d., with rebates; for power and heat, 4d.; gas 3s. 1d. Revenue per 8 C.P. lamp, 6s. 6d. Works' cost per unit, 2·05d. Managing Engineer, Frank King, 4, Great Winchester Street, E.C. Resident Engineer, Percy Still, A.M.I.C.E., 19 Cadogan Gardens, S.W.

CITY OF LONDON.—City of London Electric Lighting Company, Limited. District of St. Saviours, Southwark, also supplied.

5d. Works cost per unit 1·74; total, 2·42d. Revenue per 8-C.P. lamp 12s. Engineer-in-Chief, W. H. Patchell, 12, Maiden Lane, W.C.

ST. MARY ABBOTS, KENSINGTON.—House-to-House Electric Light Supply Company, Limited. Alternating current system with sub-stations. 5 Fowler's engines, each 180 I.H.P., and 1 of 100 I.H.P. 4 Babcock, 2 Lanc., and 2 Niclausse boilers. 5 Elwell-Parker dynamos, 2 250 H.P. and 1 150 H.P. Willans-Electric Construction Combination. Lamps connected to Dec. 31st, 1895, 44,162 35-watt; lamps connected during year, 8,394 35-watt. Capacity of station, 930 kilowatts. Price per unit (from March 25th, 1895), 6d. Total cost of works, mains, &c. (capital expenditure), to Dec., 1895, £102,380 8s. 7d. Manager and Engineer, Henry W. Bowden, Richmond Road, Earls Court, S.W.

ST. PANCRAS PARISH.—Vestry. L.T. continuous three and five-wire system and accumulators. Babcock boilers, Willans engines, 1,660-I.H.P., and Latimer Clark & Co. and Kapp multipolar dynamos. Underground mains, bare copper strip, in culvert, and armoured cables, 98 arcs, two 50 C.P. incandescent for street lighting; 139 arcs and 19,195 incandescent lamps of 16 C.P., and 37 motors used for private purposes. Present capacity of station, 30,000 64-watt lamps. Price per unit, 6d., 3d. for "day" supply; gas 2s. 11d. A second central station, in connection with a refuse destructor works, has recently been opened in the King's Road, Camden Town, giving a house service of 200 volts.

STRAND DISTRICT, ST. MARTIN'S, HOLBORN, MARYLEBONE, PADDINGTON.—Metropolitan Electricity Supply Company, Limited. H.T. alternating transformer system and low pressure continuous system. There are five stations, at the following places: Manchester Square, Sardinia Street, Rathbone Place, Amberley Road, Paddington, and at Whitehall Avenue. Babcock and Wilcox and Hick, Hargreaves boilers; engines by Parsons, Willans, Hornsby, and Allen; dynamos by Electric Construction, Kapp, Siemens, Parsons, British Thomson-Houston, and Latimer Clark, Muirhead & Co. Private lighting is equivalent to 270,000 8-C.P. Price per unit, 7½d., with sliding scale to 5½d. Engineer-in-Chief, Frank Bailey, 17, South Street, Manchester Square, W.

WANDSWORTH.—County of London and Brush Provincial Electric Lighting Company, Limited. H.T. alternating current system, with high and extra high pressure feeders, with transformer boxes under streets, supplying current to low tension mains at a pressure of 200 volts. High pressure 2,000 volts, extra high pressure 5,000 volts. Babcock-Wilcox boilers. Vertical compound engines (1,500 H.P.) direct coupled to Mordey alternators. Silvertown concentric cables sheathed with steel tape for high and extra high tension. Callender's concentric cables drawn into cast-iron pipes for low tension. Price per unit, 7d., 5d. for power, heating, &c. Engineer-in-Chief, A. J. Lawson, Moorgate E.C. Works are in course of construction.

LYNMOUTH.—The Lynton and Lynmouth Electric Light Company, Limited. H.T. alternating current system. Water power; Little Giant turbine and Pelton wheels. Lowrie-Hall and Mordey alternators. Street lighting by arc and incandescent lamps.

MANCHESTER.—Corporation. L.T. 5-wire system. 12 Lancashire boilers, 14 large vertical com. condensing engines, 400 H.P. each, 6 small vertical com. condensing engines, 100 H.P. each. Dynamos by Electric Construction Company and Mather & Platt. Underground mains, concrete culverts with bare copper mains, iron and earthenware pipes with insulated cables. No street lighting. 782 arc lamps, 88,268 8-C.P. lamps, and 46 motors, aggregating 46 H.P. Capacity of station, 124,000 8-C.P. lamps. Price per unit varies from 6d. to 2½d., according to number of hours burning. Cost of constructing and equipping central station, including land, £121,988. Cost of mains and laying, £76,653. Engineer-in-chief, Charles Henry Wordingham, Corporation Works, Dickinson Street, Manchester.

MEVAGISSEY.—Electric Lighting Company. L.T. direct. Davey-Paxman semi-portable undertype engine and locomotive boiler. Crompton dynamo, 26 kw., 60 Epstein cells. Bare copper strip system. Streets lighted by 32 16-C.P., and 2 32-C.P. lamps. 6d. per unit. Engineers, Veale & Co.

MORECAMBE.—Morecambe Electric Light and Power Company, Limited. L.T. two-wire system. Gas engines; 3 Stockport 40 I.H.P., 1 Crossley 60 I.H.P., and 1 Crossley of 150 I.H.P., these are supplied by Dowson gas apparatus. Arc lamps and incandescent lamps used in private supply equivalent to 3,200 8-C.P. 1,000 incandescents have been added during the past year. Capacity of station is about 5,600 8-C.P. Price per unit, 7d.; gas 3s. 8d. per 1,000 feet. Cost of plant about £10,000. The above works are not working. The concern, which was shut down some time ago, is being arranged to be taken over by the Council.

NELSON.—Corporation. L.T. two-wire system with accumulators. 2 Willans engines of 80 and 135 I.H.P. Lancashire boilers. Mains are laid underground in cast-iron conduits. 4 arc lamps for street lighting, and about 2,000 16-C.P. incandescents for private lighting. Capacity of station 5,000 16-C.P. lamps. Price per unit, 5d., with discount for cash.; gas 2s. 9d. per 1,000 feet. Waste heat from gas retort furnaces used for boilers. Cost of constructing and equipping central station, £9,500; mains, £5,000. Engineer, John Foster, Engineer's Office, Gas Works, Nelson.*

NEWCASTLE.—Newcastle and District Electric Lighting Company, Limited. H.T. alternating current system. 5 Lancashire boilers and Parsons turbo-electric generators, 960-unit plant. Underground mains. 10 arc lamps for street lighting, 80 arcs and 24,700 16-C.P. incandescents. 3,300 lamps added during past 12 months. Price per unit, 6d., less discount, varying from 5 to 25 per cent.; gas, 1s. 10d., less 10 per cent. Total cost of constructing and equipping central station, £57,231, includes mains and all other expenditure. Works' cost 1·71d. per unit sold. Revenue per lamp, 7s. 3d. Engineer, W. D. Hunter, 38, Granger Street West, Newcastle.

NEWCASTLE.—Newcastle Electric Supply Company. H.T. alternating current with transformers. Lancashire boilers, horizontal compound engines, 1,200 H.P., underground concentric cables. 14 arcs used for street lighting. About 31,000 30-watt lamps used for private lighting. Price per unit, 4½d. with discounts; gas 1s. 10d., less 10 per cent. Works cost 1·8d. per unit sold. Engineer, R. C. Jackson, Pandon Dene, Newcastle-on-Tyne.

NEWPORT, MON.—Corporation. H.T. alternating. 4 Lanc. boilers, 28 × 7 ft. 6 in. 4 horizontal compound condensing engines, each of 150 H.P., 1 of 120, and the day load semi-portable compound 50 H.P. engine. Alternators of the Hall type. Concentric mains in cast-iron culverts for high tension, and armoured concentric for low tension. 42 arcs used for street lighting, equivalent of 7,500 8-C.P. incandescent lamps, and 2 arcs for private lighting. Capacity of generating station, 12,000. Abercarn black vein coal used. Price per unit, 6d., with discounts; gas, 3s. About £20,000 expended. Engineer-in-chief, Charles D. Copland, Eccleston, Mill Street, Newport.

NORTHAMPTON.—Northampton Electric Light and Power Company, Limited. L.T. direct current. 3 Daniel Adamson Lancashire boilers, 3 Scott & Hodgson's vertical compound engines, each of 120 I.H.P., and Crompton dynamos. Crompton system of underground mains. 30 arcs and

C.P. Capacity of works, 10,000 8-C.P. 7d. per unit; gas, 2s. 6d. Oak coke used for boilers. Cost of constructing works, £40,000. Engineer-in-Chief, Chas. L. Turner, Electricity Works, Wallness Road, Broughton, Manchester.

SCARBOROUGH.—Scarborough Electric Light Company, Limited. H.T. alternating (2,000 v.) system, with street box transformers in part of the town. 3 Lanc. boilers, 3 150-kw. and 1 75-kw. Parsons steam turbine alternators and exciters. 30 arcs and 12,492 8-C.P. incandescent lamps for houses. Underground mains consisting of India-rubber non-concentric cables drawn into cast-iron pipes. Capacity of station, 17,500 80-watt lamps. Price per unit, 6½d. to 5½d. according to consumption; gas 3s., with discount of 9d. Managing Director and Engineer-in-chief, A. A. C. Swinton, 66, Victoria Street, Westminster. Resident Engineer, G. S. Peck, 102, Westborough, Scarborough.

SHEFFIELD.—Sheffield Electric Light and Power Company, Limited. H.T. alternating system with transformer sub-stations. 6 engines, 1,600 H.P., 6 boilers, 2,100 H.P., 28,000 8-C.P. lamps. Present capacity of station, 30,000 8-C.P. lamps. Price per unit, 6d.; price of gas, 2s. Works' cost per unit, 2·69d. Annual revenue per 8-C.P. lamp, 5s. 6d. Manager and Secretary, Wm. Johnson, M.I.E.E.

SHREWSBURY.—Shropshire Electric Light and Power Company, Limited. L.T. three-wire. 3 60 H.P. Babcock boilers, 3 50 H.P. Belliss engines, driving 3 Parker dynamos. Armoured concentric cables for feeders, and 3-core Callender armoured cables for distribution. 1,200 8-C.P. lamps and 9 arc lamps for private lighting. Capacity of works, 3,000 8-C.P. lamps. 7d. and 6d. per unit; gas, 3s. Cost of constructing and equipping works, £13,000. Engineer-in-Chief, Mr. Cuthbert, Wigham.

SOUTHAMPTON.—Southampton Electric Light and Power Company, Limited. Low tension three-wire with accumulators. 2 Willans 100 I.H.P. engines, 1 Willans 60 I.H.P. engine, 1 Belliss 135 I.H.P. engine, high speed, 1 Robey 120 I.H.P. engine, slow speed, all driving Crompton dynamos. Underground mains on Crompton system. 70 arcs (private) of various sizes. Lamps connected 5,000 8-C.P., including arcs, but excluding cranes, approximately 1,500 8-C.P. Capacity of station, 8,000 8-C.P., with all plant in use (including crane plant). Price, 7d., with sliding scale; power, 6d.; gas, 2s. 3d. Cost of station and mains approximately, £19,000. Revenue per 8-C.P. in 1895, 9s. 6d. Works' cost in 1895, 3·2d. per unit sold. The business is to be taken over by the Corporation after the 31st inst. Engineer, J. H. Lee, Central Electric Light Station, Back of the Walls, Southampton.

SOUTHPORT.—Corporation. H.T. alternating (2,000 v.) system, with sub-stations. 2 Lancashire boilers, 3 Browett & Lindley engines and Mather and Platt alternators, rope driven, of 160 kilowatts capacity. Underground mains, concentric armoured cables. The boilers are constructed for burning coke breeze from the Corporation Gas Works. 20 arcs and 4,000 8-C.P. for private lighting. Cost per unit, 7d.; gas, 3s. Works have cost about £13,000, mains cost about £5,500. Engineer, Arthur Ellis, Town Hall.* (Mr. Ellis has been appointed to Bolton.)

SOUTH SHIELDS.—Corporation. H.T. (2,000 volts) alternating street transformers, L.T. distribution at 110 volts. 2 triple vertical 300 I.H.P. engines, and 1 35 I.H.P. compound vertical engine, all condensing Rubber cables in cast-iron pipes. 14 arcs and 4 incandescent lamps on each post for street lighting. Capacity of works, 6,450 8-C.P. 6d. per unit, with rebates down to 3d.; 3d. for heaters, and 2d. for motors; gas, 2s. 6d. Cost of constructing and equipping works, £27,500. Engineer-in-Chief, J. A. Jeckell.

STAFFORD.—Corporation. 3 Lanc. boilers, 3 Horizontal compound engines, with Corliss valve gear, 150 H.P. each. Electric Construction Corporation dynamos. Vulcanised rubber cables in earthenware pipes. Few arc lamps for streets, 2,000 8-C.P. lamps for private lighting. Capacity of works, 6,000 8-C.P. lamps. Price per unit, 8d. and 4d.; gas, 2s. 3d. to 2s. 10d. Cost of constructing and equipping works, £16,000. Engineer-in-Chief, J. F. Bell.

SUNDERLAND.—Corporation. L.T. three-wire for central area, and L.T. alternating for outlying districts. Lanc. boilers, Willans engines, Holmes's continuous current machines and Crompton alternators. B.I.W. cable in Doulton casing for H.T., and Silverton cable in Doulton casing for L.T., transformers buried in streets. Capacity of works, 7,000 8-C.P. lamps. 6d. per unit, with discounts from 2½ to 20 per cent.; gas, 1s. 6d. Engineer-in-Chief, C. S. Vesey Brown.

TAUNTON.—Corporation. H.T., alternating current system (Thomson-Houston) for private lighting, and Thomson-Houston and Brockie-Pell series arc lamps. Babcock and Davey-Paxman boilers. 2 Willans engines, indicating 135 H.P. each; 2 Ruston, Proctor & Co.'s, indicating 75 H.P.; one Bumsted-Chandler, indicating 50 H.P.; 1 Belliss engine, indicating 180 H.P., and 1 T.H. alternator of 90 units; 2 Thomson-Houston alternators of 70 units each; and one Thomson-Houston of 30 units. 4 T.H. arc lighters of 30 lights each, and one 10½ unit Elwell-Parker dynamo. There are 52 and 50 public incandescent of 25 and 16 C.P. public and 40 private arc lamps and 5,000 of 8-C.P. incandescent lamps installed. Mains are Fowler-Waring concentric lead covered steel armoured, laid direct in ground, with sub-stations and distributed transformers. Price per unit, 6d.; gas, 3s. 6d. Price of coal is 14s. 6d. Borough Electric Engineer, Harold W. Couzens, St. James Street, Taunton.

THETFORD.—Thetford Electric Light Company. L.T. system. 2 50-H.P. boilers, 1 20-H.P. engine, 1 10-H.P. engine. Lawrence-Scott dynamos. Overhead and underground mains. 70 arc lamps and 600 8-C.P. lamps. Capacity of station 1,800 8-C.P. lamps, with addition of 5 motors of 1 H.P. each. Price per unit, 6d. and 7d., price of gas, 5s. Total cost of constructing and equipping central station £3,000. Engineer, R. Carter.

TUNBRIDGE WELLS.—Corporation. H.T. (2,000 volts) alternating. Babcock & Wilcox boilers, Willans engines, Johnson & Phillips (Kapp) alternators. Callender's concentric armoured cables. 30 arcs and 100 16-C.P. lamps in streets. Arcs run off Ferranti rectifiers. 7,000 8-C.P. for private lighting. Capacity of works, with extensions now in hand, equal to 10,000 8-C.P. burning at one time. 6d. per unit; gas, 3s. Cost of constructing and equipping works, including mains, £35,000. Engineer-in-Chief, H. L. P. Boot.

WALSALL.—Corporation. Oxford system, high tension continuous current (2,000 volts), with motor generator transformers. 2 Lanc. boilers 300 H.P. each, 3 Chandler engines 120 I.H.P. each, 2 Chandler engines 12 I.H.P. each. Parker dynamos. Concentric rubber covered cable drawn in iron pipes for H.T. feeders, Callender's armoured

Rider, Spa Road, Bolton. (Mr. Rider has resigned, Mr. Arthur Ellis has been appointed.)

Now erecting.—Fourth boiler; another Hick, Hargreaves-Ferranti combined plant; 2 miles mains; motor alternator for light loads.

BOURNEMOUTH.—Bournemouth and District Electric Supply Company. H.T. alternating current. Mordey-Victoria alternators and Brush engines, of 1,250 I.H.P., Babcock boilers 1,250 H.P. Mains, buried armoured cables and rubber cables drawn into cast-iron pipes. 20,567 8-C.P. incandescent lamps, wired for private supply. 1,797 lamps added during 1895. Capacity of station, 16,500 8-C.P. lamps used simultaneously. Price per unit, 7d.; gas, 3s. 6d. Annual revenue per 8 C.P., about 7s. 6d. Works' cost 3·66d. per unit sold 1895. Engineer, H. M. Sayers, Verulam House, Yelverton Road, Bournemouth.

BRADFORD.—Corporation. Low tension three-wire system with batteries. Lowest pressure, 230 volts; highest, 460 volts. 11 Siemens dynamos, Willans engines; 5 Lanc. boilers, 2 marine induced draught boilers; armoured cable (underground). About 40,000 8-C.P. lamps connected for private lighting. No public lighting. Price per unit, 5d. for light; 3½d. for motive power. Price of gas, 2s. 3d. Works' cost per unit, 1·57d. Annual revenue per 8-C.P. lamp, 6s. 10d. Engineer-in-Chief, Alfred H. Gibbings, Town Hall, Bradford.

BRAY (IRELAND).—Bray Township Commissioners. High tension alternating system (1,000 volts), with two wire low-tension distribution from transformer sub-stations. Brush Falcon 120 H.P. engine; Davey-Paxman 40 H.P. loco. boiler; 2 Victor turbines 40 H.P.; 80 arc lamps, and 108 incandescent lamps of 25 C.P. for street lighting; private lighting equivalent to 1,230 8-C.P. Price per unit, 8d., or by contract. Present capacity of station in 8 C.P., 3,500. 384 lamps added during past year. Price of gas, 4s. 9d. Annual revenue per 8-C.P. lamp, 10s. 1d. The Commissioners purchased the station for £3,000, on January 1st, 1896. Resident Engineer, G. Marshall Harris, Bray Mills, Ireland.

BRIDLINGTON.—Municipal Authority. Thomson-Houston arc-lighter. Motive power hired from sawmill. 18 arcs of 1,200 C.P. each Lamps run during summer season. Engineer, R. Railton Brown.*

BRIGHTON.—Corporation. L.T. three-wire continuous current system, worked in combination with a H.T. alternating transformer substation system in the residential districts. Willans steam dynamos, total I.H.P. 2,000. Lancashire and water-tube boilers. Underground armoured cables. 260 arc lamps and about 1,200 incandescent lamps installed or about to be installed for street lighting. Equivalent number of 8-C.P. lamps actually installed for private lighting, 53,000. Number added during past 12 months, 14,000. Consumption of electricity charged on the "Wright" system of 7d. per unit for the first hours' daily use, and 3d. per unit afterwards; gas, 2s. 9d.; coal, 20s. 6d. Capital sunk in undertaking, £151,542 16s. 8d. Cost of mains, £68,059 11s. 2d. Manager and Engineer, Arthur Wright.

BRIGHTON COMPANY.—(*See* **HOVE.**)

BRISTOL.—Corporation. H.T. alternating current system, with low tension distributing network. Arc lighting by continuous current. Lanc. boilers, with elevator, conveyor, and mechanical stokers; 9 Willans engines, 5 Siemens alternators, 4 Siemens continuous current dynamos. Underground mains, Siemens concentric cables. H.T. concentric, L.T. triple concentric, arc light single, all steel and lead armoured. 108 arcs for public lighting, 28,000 8-C.P. lamps connected for private lighting. Capacity of station, 27,000 8-C.P. Price, 6d. per unit; day load and power supply, 4d., subject to discount up to 20 per cent.; gas, 2s. 8d. Cost of station, £100,000. City Electrical Engineer, H. Faraday Proctor, C.E., M.I.E.E., Temple Back, Bristol.

BUCKINGHAM.—Buckingham Electric Light Company. L.T. system with accumulators. 40 H.P. by water, 50 H.P. by steam. Elwell-Parker & Goolden dynamos. Overhead wires. About 1,500 16-C.P. incandescents used for private lighting. Station cost £3,500. Engineers, Gillies and Hornidge.

BURNLEY.—Corporation. Low tension, 3-wire, with accumulators. 3 horizontal compound Corliss condensing engines, by the Burnley Ironworks Co., Ltd., total 610 I.H.P., 3 two-pole shunt dynamos by the Electric Construction Co., Ltd., 330 kw., Callender's bituminised-fibre cables, lead covered and steel armoured. Private lighting equivalent to 9,800 8-C.P. lamps. Capacity of station, 10,000. Capital expenditure, £23,500, Average consumption per 8-C.P. lamp, 15 units. Electrical Engineer, F. Thursfield, B.A., A.M.I.C.E., Electric Lighting Station, Burnley.

BURTON-UPON-TRENT.—Corporation. High tension alternating system. 3 Lancashire boilers. 3 horizontal compound engines of 106 Brake H.P. each. 3 Hall alternators. 2 arcs, 3,500 8-C.P. equivalents for private lighting. Capacity of station, 4,000 8-C.P. 6d. per unit; gas, 3s. Refuse from gas-works used for fuel. Cost of constructing and equipping central station, £25,000. Electrical Engineer, F. L. Ramsden, Gas and Electric Light Works, Burton-on-Trent.

CAMBRIDGE.—Cambridge Electric Light Company. H.T. alternating system (2,000 v.). 3 Lancashire boilers, 4 Parsons steam turbo-alternators. Underground mains, vulcanised rubber cables placed in iron pipes. About 15,902 8-C.P. incandescent lamps are connected. Present capacity (1896 actual) of station 525 kw.; units consumed annually per 8-C.P. lamp, 11·44; revenue per lamp, 6s. 7d. Manager and Engineer, J. H. Barker.

CARDIFF.—Corporation. High tension alternating with transformers in street boxes. Compound and triple expansion engines, 2 of 75 H.P., 2 of 300 H.P. each. 3 300-H.P. Economic boilers. 48 arcs for street lighting. High tension cable, concentric (Silvertown). Price per unit (Wright's system adopted), 6d.; gas, 2s. 10d. Cost of constructing and equipping central station has not exceeded £32,500. Ferranti rectifiers are employed. Extension of plant in hand to the amount of £12,500. Engineer, W. Harpur.

CARLOW.—Electric Lighting Company. H.T. alternating current. Water and steam power. No further information.

partly done from L.T. mains, 4 arcs in series, and partly by H.T. series lighting current rectified by Ferranti rectifiers, 247 arcs. 50,000 8-C.P. connected for private lighting. 6d. per unit, with rebate; 3½d. for power; gas, 3s. Cost of constructing and equipping works, including mains, £130,000. Engineer-in-Chief, F. A. Newington.

EXETER.—Exeter Electric Light Company. H.T. alternating and H.T. series arc. Two compound horizontal, non-condensing engines, 120 H.P. each, and 1 80-H.P. by Fowler, and two Westinghouse triple expansion engines of 25 H.P. 3 Babcock boilers, 150-H.P. each. Underground mains, Fowler-Waring concentric cable. 21 arcs and 7,000 8-C.P. for private lighting. Capacity of station, 6,600 8-C.P., and 60 arc lamps; 1,000 lamps added during the past year. Price per unit. 6d. with rebate; price of gas, 3s. Cost of station, £11,000. Cost of mains, £8,000. Works' costs per unit, 3·78d.; total costs per unit, 4·44d. Revenue per 8-C.P. lamp, 7s. 6d. (on average of lamps for year). Engineer, H. D. Munro, Rockfield Works, Exeter.

FAREHAM.—Fareham Electric Light Company. Thomson-Houston system. Ransomes, Sims & Co. compound engines. Overhead and underground mains. 20 arcs and 90 incandescent lamps for street lighting, and 230 16-C.P. incandescent lamps for private lighting. Price to consumers 1s. per C.P. per annum and 8d. per unit; gas 3s. 9d. Station, with mains, cost originally £5,000. Works just transferred to Local Authority, Fareham Urban District.

GALWAY.—Galway Electric Light Company. Low tension system. Crompton and Statter dynamos; 2 Hercules turbines. 5 arcs and 4 incandescents for docks; 2,000 8-C.P. incandescent for private lighting. Price per unit, 5d.; for power, 3d.; gas, 5s. 6d. Engineer, James Perry, M.I.C.E.

GLASGOW.—Corporation. L.T. three-wire system, with accumulators for private lighting. 3,000 v. arc machines for street lighting. Latimer Clark-Muirhead and Siemens dynamos and Willans engines, 2,600 I.H.P. 6 boilers of 300 H.P. each, by Lindsay, Burnet & Co., and 2 of 700 H.P. each, by Babcock & Wilcox. Brush machines for street lighting. Arc light mains are of rubber insulation drawn into iron pipes. L.T. network copper strip in C.I. culverts. About 112 arc lamps have been erected in the streets. 63,560 8-C.P. incandescent lamps for private lighting. Capacity of station, 40,560 8-C.P. lamps. Price per unit, 6d.; gas, 2s. 4d. Cost of system including the taking over of Mavor and Coulson stations up to May, 1895, £141,310. Engineer-in-Chief, W. Arnot.

GLASGOW (KELVINSIDE).—The Kelvinside Electricity Co., Ltd. L.T. three-wire system, with E.P.S. accumulators (at present working on two-wire system). 2 Babcock & Wilcox boilers, 250 H.P., 2 Willans engines, direct coupled to Goolden dynamos, 150 kilowatt capacity. Callender's lead covered and armoured cables. Lamps connected, 5,500 8-C.P. for private lighting. Capacity of station, 5,000 8-C.P. lamps alight at one time. Meters principally Kelvin. Price per unit, 6d.; gas, 2s. 4d. Works cost 2·58d. per unit. Annual revenue per 8-C.P. lamp, 2s. 9d. District purely residential, 80 per cent. houses completely closed during summer months, hence small revenue per lamp. No public lighting at present. Resident Engineer, A. D. Brigham.

HALIFAX.—Corporation. High tension alternating system. Compound horizontal and vertical engines, 1,100 H.P. Underground mains vulcanised, in iron pipes. 20 arcs and 11,000 8-C.P. lamps for private lighting. Capacity of station, when completed, 60,000 8-C.P. lamps. 6d. per unit, 5 per cent. discount for cash. Price of gas, 2s. 2d. Station about completed. Total cost, £40,500. Mains, £11,000. Electrical Engineer, T. P. Wilmshurst.

HANLEY.—Corporation. H.T. alternating current with transformers at sub-stations. 5 boilers, 2 com. vertical engines, 200 H.P. each, one of 500 H.P., 3 engines and dynamos (continuous current) for street lighting, 30 arc lamps, rectifiers for two circuits, of 30 arc lamps each. 13,000 8-C.P. and 35 alternating arcs used for private lighting. Underground mains, primary concentric in cast-iron pipes, also paper insulated concentric cables in compound troughs. Low pressure in cast-iron troughs filled up with bitumen, also paper concentric cables. The capacity of the station is 20,000 lamps of 8-C.P. Price per unit, 5d. Churches and chapels, 4d., and motive power 3d., all subject to 5 per cent. discount for cash within 21 days; gas costs 2s. 3d. Joseph Lobley, borough engineer. Engineers in charge, C. A. Cowell and C. J. Sutherland.

HASTINGS.—Hastings and St. Leonards Electric Light Company, Limited. H.T. alternating current with transformers. Brush engines and Mordey alternators. Underground mains. 9,872 32-watt lamps, including 76 arc lamps. Wright's system of charging, 9d., reduced to 4d., after 2 hours; gas, 3s. per 1,000. Revenue per lamp connected, 13s. 10d. Works' costs per lamp, 3·34d. Engineer, L. Andrews.

HOVE.—Hove Electric Lighting Company, Limited. Low pressure 3-wire system. 3 Willans engines, 100-H.P. each. 1 Bellias 150-H.P., and 1 Willans 250-H.P., all coupled direct to Crompton dynamos. Bare copper mains in culverts. Private lighting equivalent to 18,403 33-watt lamps. Charges, 8d. per unit first two hours, 4d. afterwards. Motive power, 4d. per, unit; gas, 2s. 9d. Expenditure to date approximately £57,472. Works' cost per unit 2·53d. Revenue per 33-watt lamp, 6s. 2d. Resident Engineer, C. Bottomley Smith, Cromwell Road, Hove.

HUDDERSFIELD.—Corporation. H.T. alternating current with transformers, Mordey-Victoria alternators, 4 Brush engines of 1,000-H.P., 1 Ferranti alternator with McLaren's engine, 550 H.P., and 4 200-H.P. Babcock boilers. High tension mains are concentric, insulated with vul. I.R.; low tension mains are bitumen covered; also high and low tension mains with paper insulation. Only 4 arc lamps at present for street lighting, 22,000 8-C.P. incandescent for private lighting. Capacity of station, 26,000 8-C.P. lamps. Price per unit, for lighting, 6d., with sliding discounts to 4½d.; gas, 2s. 9d.; cooking, heating, and motive power, 2½d. per unit. Coke, 5s. 6d. per ton; slack, 3s. 3d. per ton. Capital expenditure, £52,000. Works' cost 1·46d. per unit. Annual revenue per 8-C.P. lamp, 5s. 11d. Borough Electrical Engineer, A. B. Mountain.

HULL.—(*See* **KINGSTON-UPON-HULL.**)

KELVINSIDE.—(*See* **GLASGOW.**)

LONDON DISTRICTS:—

BELGRAVIA and PIMLICO.—Westminster Electric Supply Corporation, Eccleston Place Station. L.T. system, generated at 200 v. and distribution in two parallels of 100 volts each. Willans and Davey-Paxman engines. I.H.P. of engines, 1,750. Davey-Paxman "Economic" boilers, and Fraser of same kind. Crompton and Siemens dynamos. Underground mains, bare copper in culverts, and insulated cable in Callender conduit. Resident Engineer, C. O. Grimshaw.

MAYFAIR.—Westminster Electric Supply Corporation, Davies Street Station. Same system as at Eccleston Place. Willans engines Paxman and Fraser boilers. I.H.P. of engines, 3,000. Crompton and Elwell-Parker dynamos. Same system of mains as other stations. Engineer-in-Chief, Prof. A. B. W. Kennedy. Resident Engineer, Ll. Foster.

WESTMINSTER.—Westminster Electric Supply Corporation, Millbank Street station. Same system as other stations belonging to this company. Willans engines, Babcock boilers. Total lamp connections for the three stations of this company amount to 210,000 32-watt lamps, about 43,000 lamps have been added during 1895. Total I.H.P. of three stations 6,400. I.H.P. of engines at Millbank Street, 1,680. Works' cost per unit sold, 1·40; total cost per unit sold, 2·32. Revenue per 32-watt lamp, 7s. 2d. including meter rents. Engineer-in-Chief, Prof. A. B. W. Kennedy. Resident Engineer, W. Robinson.

CHELSEA.—Chelsea Electricity Supply Company, Limited. System, continuous current with motor-generators and batteries, feeding into a network at 100 volts. Electric Construction dynamos, Willans engines, Babcock boilers. Underground mains on Callender-Webber system. Equivalent of 60,400 8-C.P. lamps; 10,000 added during the past year. Capacity of station, 50,000 8-C.P. lamps. Price per unit for light, 6d., with rebates; for power and heat, 4d.; gas 3s. 1d. Revenue per 8 C.P. lamp, 6s. 6d. Works' cost per unit, 2·05d. Managing Engineer, Frank King, 4, Great Winchester Street, E.C. Resident Engineer, Percy Still, A.M.I.C.E., 19 Cadogan Gardens, S.W.

CITY OF LONDON.—City of London Electric Lighting Company, Limited. District of St. Saviours, Southwark, also supplied. H.T. alternating system with transformer stations, and L.T. three-wire distribution. Bankside Works, engines by Brush Company, Willans, Ferranti, Browett-Lindley, and Chandler. Alternators by Brush Company, British Thomson-Houston, and Ferranti. Arc machines by Brush Company and British Thomson-Houston. Underground cables, chiefly British Insulated Wire Company, some Silvertown, Siemens, Glover, Fowler-Waring, and Callender. 520 arcs for streets, &c., and about 200,000 lamps of 8-C.P. for private lighting. Price per unit, 8d., with sliding scale. Engineer, Frank Bailey.

CLERKENWELL and ST. LUKES.—County of London and Brush Provincial Electric Lighting Company, Limited. H.T. 2,000-volt alternating current system, with transformer boxes under pavement. Babcock boilers, vertical compound engines, 8,000 H.P., 6 Mordey alternators, and 6 by Electric Construction Corporation, direct coupled to engines. B. I. W. Co.'s concentric lead-sheathed cables for high tension, and Callender's concentric lead-sheathed cables drawn into cast-iron pipes for low tension. 7,000 8-C.P. lamps applied for. Price per unit, 7d., 5d. for power, heating, or cooking. Engineer-in-Chief, A. J. Lawson, Moorgate Court, E.C. Works are in course of construction.

CRYSTAL PALACE.—Crystal Palace District Electric Supply Company. High tension system with motor generators in sub-stations. Hornsby engines and boilers (5 of each), 10 batteries of accumulators in 8 sub-stations. Electrical plant by the Electrical Construction Company, Limited. 9,500 incandescent and 37 arcs used for private lighting. Capacity of stations, 30,450 8-C.P. lamps. Price per unit, sliding scale, 7d., 6½d., and 6d., according to quarter's consumption; gas, 2s. 8d. Total outlay, £73,688. Resident engineer, P. J. Rea.

EALING.—Urban District Council. High pressure alternating current for private lighting, high pressure continuous for public lighting. Siemens dynamos and Browett & Lindley engines, Lancashire boilers. Fryer refuse destructors are used in conjunction with steam raising plant. Horse-power of station about 1,000. Distribution is done by means of transformer sub-stations. 76 arc lamps in the streets. Capacity of station, 15,000 8-C.P. lamps.

HAMPSTEAD.—The Vestry. High pressure alternating, with transformer sub-stations, distribution on three-wire low pressure. Public arc lighting on continuous current series system. 4 200-H.P. Lanc. boilers, Willans engines of 1,000 B.H.P. Siemens alternators and continuous current machines. High pressure concentric feeders, lead cased, armoured, low pressure network, Siemens triple concentric mains. 23 arcs for street lighting, 22,000 8-C.P. lamps for private lighting. Capacity of station, 18,000. 6d. per unit with sliding scale; gas, 2s. 10d. Cost of constructing and equipping central station, £50,000 approx. Resident engineer, Geo. H. Cottam, Electricity Department, Lithos Road, Finchley Road, N.W.

ISLINGTON.—Vestry of the Parish of St. Mary. H.T. (2,000 volts) alternating with street transformers, and L.T. (100 volts) distributors. 4 Lanc. and 2 Babcock boilers, 4 Adamson-Wheelock compound horizontal engines, 2 driving by ropes Fowler alternators, and 1 Fowler and 1 Ferranti fly-wheel alternators. Silvertown concentric armoured mains in iron pipes. 9⅛ 12-ampere lamps, using rectified currents for street lighting, 6,000 8-C.P. lamps connected for private lighting; 16,000 applied for. Capacity of works, 14,000 35-watt lamps burning at one time. 7d. per unit, with rebates; gas, 2s. 10d. Total capital expenditure, £80,000. Engineer-in-Chief, Albert Gay, Eden Grove, Holloway. Assistant Engineer, C. H. Yeaman.

NOTTING HILL and part of ST. MARY ABBOTTS.—Notting Hill Electric Lighting Company. L.T. direct current system. Babcock and Wilcox boilers, Willans engines, two of 200 and two of 100 H.P., and Crompton dynamos. Underground mains on three-wire system. 15,000 incandescent lamps used for private lighting. Capacity of station, 15,000 8-C.P. Price per unit, 8d., subject to discount. The revenue per lamp is about 7s. Cost of station, £29,000. Cost of mains, £41,000. Works' cost 2·3d. per unit. Engineer-in-Chief, George Schulz, Bulmer Place, Notting Hill Gate.

underground in cast-iron conduit. 4 arc lamps for street lighting and about 2,000 16-C.P. incandescents for private lighting. Capacity of station 5,000 16-C.P. lamps. Price per unit, 5d., with discount for cash.; gas 2s. 9d. per 1,000 feet. Waste heat from gas retort furnaces used for boilers. Cost of constructing and equipping central station, £9,500; mains, £5,000. Engineer, John Foster, Engineer's Office, Gas Works, Nelson.*

NEWCASTLE.—Newcastle and District Electric Lighting Company, Limited. H.T. alternating current system. 5 Lancashire boilers and Parsons turbo-electric generators, 969-unit plant. Underground mains. 10 arc lamps for street lighting, 80 arcs and 34,700 16-C.P. incandescents. 3,200 lamps added during past 12 months. Price per unit, 6d., less discount, varying from 5 to 25 per cent.; gas, 1s. 10d., less 10 per cent. Total cost of constructing and equipping central station, £57,331, includes mains and all other expenditure. Works' cost 1·71d. per unit sold. Revenue per lamp, 7s. 3d. Engineer, W. D. Hunter, 38, Granger Street West, Newcastle.

NEWCASTLE.—Newcastle Electric Supply Company. H.T. alternating current with transformers. Lancashire boilers, horizontal compound engines, 1,200 H.P., underground concentric cables. 14 arcs used for street lighting. About 31,000 30-watt lamps used for private lighting. Price per unit, 4½d. with discounts; gas 1s. 10d., less 10 per cent. Works cost 1·8d. per unit sold. Engineer, R. C. Jackson, Pandon Dene, Newcastle-on-Tyne.

NEWPORT, MON.—Corporation. H.T. alternating. 4 Lanc. boilers, 28 × 7 ft. 6 in. 4 horizontal compound condensing engines, each of 150 H.P., 1 of 120, and the day load semi-portable compound 50 H.P. engine. Alternators of the Hall type. Concentric mains in cast-iron culverts for high tension, and armoured concentric for low tension. 42 arcs used for street lighting, equivalent of 7,500 8-C.P. incandescent lamps, and 2 arcs for private lighting. Capacity of generating station, 12,000. Abercarn black vein coal used. Price per unit, 6d., with discounts; gas, 3s. About £20,000 expended. Engineer-in-chief, Charles D. Copland, Eccleston, Mill Street, Newport.

NORTHAMPTON.—Northampton Electric Light and Power Company, Limited. L.T. direct current. 3 Daniel Adamson Lancashire boilers, 3 Scott & Hodgson's vertical compound engines, each of 120 I.H.P., and Crompton dynamos. Crompton system of underground mains. 30 arcs and 6,130 incandescents used for private lighting. Capacity of station, 7,600 8-C.P. Price per unit, 8d. and 4½d., less 5 per cent.; gas 2s. 4d. per 1,000. Revenue per 8-C.P. lamp, 7s. 4d. Cost of constructing and equipping central station, £20,000. Works' cost per unit, 3·8d. Engineer, W. E. J. Heenan, Electric Light Station, Northampton.

NORWICH.—Norwich Electricity Company. L.T. continuous current three-wire system. 3 Willans G.G. engines, 3 H.H. engines, and 1 H. engine. 4 Babcock-Wilcox boilers, 140 H.P. each (nominal). 7 miles underground mains, bare copper, about 2,000 yards laid in culverts, and the rest in earthenware pipes on Scott system. 1 battery sub-station in residential district, 1,000 yards from central station, 124 66-k. E.P.S. cells. Maximum output of station, 3,500 ampères (110 volts). Capacity of station in lamps, 14,000 8-C.P. Price per unit, 8d. for the period of day between an hour before sunset and 8 p.m., rest of day and night, 4d.; motors running continuously through the day, 3d. per unit. Works' cost for 1895 1·99d. per unit sold. Revenue per 8-C.P. lamp alight at time of maximum load, 10s. 4d. Engineer, F. M. Long, Duke Street, Norwich.

NOTTINGHAM.—Corporation. L.T. 3-wire system. 3 Willans engines of 80 I.H.P., and 4 of 134 I.H.P. Lancashire boilers. Underground mains on Callender-Webber system. 27 arcs and 17,000 8-C.P. used for private lighting. Capacity of station, 11,000 8-C.P. lamps. 6d. per unit, price of gas, 2s. 4d. Cost of station, £50,200, feeders and distributors, £10,000. Engineer, H. Talbot, Nottingham.

OGMORE VALLEY.—A company. Low pressure system. Information not up to date.

OLDHAM.—Corporation. Low pressure 2-wire. 2 Lancashire boilers of 350 H.P. each. Willans engines, 2 200 H.P., 2 100 H.P., and 2 60 H.P. each. Bare copper strip in culverts where possible, elsewhere Siemens and British Insulated Wire Company's cables in cast-iron pipes. 16 arc lamps for street lighting, 11,830 8-C.P. lamps connected (March 25th, 1895). 6d. per unit; gas, 2s. 3d. net. Crompton Howell and E.P.S. batteries. Works' costs per unit, first year, 2·18d. Annual revenue per 8-C.P. lamp, first year, 8s. 6d. Consulting Engineer, Professor Alex. B. W. Kennedy; Borough Electrical Engineer, S. Willmott, Newington.

OSWESTRY.—Oswestry Electric Lighting and Power Company, Limited. L.T. two-wire system. Marshall & Sons multitubular boilers. Undertype compound steam engines of 120 H.P. Parker's dynamos. Callender's system of mains in conduits. 6 arc lamps in market, and 483 incandescent lamps for private lighting. Capacity of works, 2,000 8-C.P. lamps. Welsh coal used. Price per unit, 6d., with rebate of 2½ per cent. after two hours maximum. Gas, 3s. 1½d. Total cost of constructing and equipping station, £3,600. Engineer, E. Bremner-Smith.

OXFORD.—Oxford Electric Light Company.—H.T. continuous current with motor-generator transformers. 4 triple expansion engines, surface condensing, marine type of 300 H.P. each (McLaren), 3 loco. boilers (McLaren) of 400 H.P. each; dynamos by Electric Construction Company, Limited. Underground mains, H.T. Silvertown, L.T. Callender's lead covered. 32 arcs used for street lighting, 24 arcs and 14,557 8-C.P. lamps for private lighting, 3,797 8-C.P. added during the past year, making an equivalent of 15,000 8-C.P. lamps connected. Capacity of station, 20,000 8-C.P. Price per unit, 8d., with 5 per cent. discount on accounts paid within the month; gas 3s. 2d. per 1,000. Annual revenue per 8-C.P. lamp, 8s. 6d. Engineer and Manager, J. Hardie McLean, M.I.E.E., 45, Broad Street, Oxford.

PONTYPOOL.—Electric Lighting Company. L.T. system. No further information.

PORTSMOUTH.—Corporation. H.T. alternating (2,000 volts). Lancashire boilers. 3 400-H.P. horizontal compound engines, by Yates & Thom, are combined with 3 Ferranti alternators; a Parson turbine drives an alternator. 8 Rectifiers are used for 253 street lamps. Underground mains on Johnstone's patent subway system, and Jennings' stoneware conduits; cables by Glovers. Engineer, E. Price, Gunwharf Road, Portsmouth.

Bumsted-Chandler, indicating 60 H.P.; 1 Bellias engine, indicating 150 H.P., and 1 T.H. alternator of 90 units; 2 Thomson-Houston alternators of 70 units each; and one Thomson-Houston of 30 units. 4 T.H. arc lighters of 30 lights each, and one 10½ unit Elwell-Parker dynamo. There are 52 and 50 public incandescent of 25 and 16 C.P. public and 40 private arc lamps and 5,000 of 8-C.P. incandescent lamps installed. Mains are Fowler-Waring concentric lead covered steel armoured, laid direct in ground, with sub-stations and distributed transformers. Price per unit, 6d.; gas, 3s. 6d. Price of coal is 14s. 6d. Borough Electric Engineer, Harold W. Couzens, St. James Street, Taunton.

THETFORD.—Thetford Electric Light Company. L.T. system. 2 50-H.P. boilers, 1 20-H.P. engine, 1 10-H.P. engine. Lawrence-Scott dynamos. Overhead and underground mains. 70 arc lamps and 600 8-C.P. lamps. Capacity of station 1,800 8-C.P. lamps, with addition of 5 motors of 1 H.P. each. Price per unit, 6d. and 7d., price of gas, 5s. Total cost of constructing and equipping central station £3,000. Engineer, R. Carter.

TUNBRIDGE WELLS.—Corporation. H.T. (2,000 volts) alternating. Babcock & Wilcox boilers, Willans engines, Johnson & Phillips (Kapp) alternators. Callender's concentric armoured cables. 30 arcs and 100 16-C.P. lamps in streets. Arcs run off Ferranti rectifiers. 7,000 8-C.P. for private lighting. Capacity of works, with extensions now in hand, equal to 10,000 8-C.P. burning at one time. 6d. per unit; gas, 3s. Cost of constructing and equipping works, including mains, £25,000. Engineer-in-Chief, H. L. P. Boot.

WALSALL.—Corporation. Oxford system, high tension continuous current (2,000 volts), with motor generator transformers. 2 Lanc. boilers 300 H.P. each, 3 Chandler engines 120 I.H.P. each, 2 Chandler engines 12 I.H.P. each. Parker dynamos. Concentric rubber covered cable drawn in iron pipes for H.T. feeders, Callender's armoured cable for low tension distributors. 44 arc lamps projected for streets. 33 arc lamps and equivalent of 2,820 8-C.P. lamps for private lighting. Capacity of works, 3,000 8-C.P. 6d. per unit for light; 4d. for day power, with 2½ discount; gas, 2s. 6d. Cost of constructing and equipping, £16,000. Engineer-in-Chief, Alexander Wyllie, Wolverhampton Street, Walsall.

WEYBRIDGE.—Electric Light Company. Thomson Houston system. Two 75-H.P. compound engines, and one 160-H.P. boiler. 500 16-C.P. lamps in use. Overhead wires. Company is in voluntary liquidation.

WHITEHAVEN.—Corporation. L.T. two-wire system for street lighting, and low tension three-wire for private lighting. Two Lancashire boilers, total H.P., 500. Six Willans engines and Crompton dynamos, total H.P., 360. Underground mains by Siemens. The streets and harbour lighted by 500 incandescent lamps of 8 to 64 C.P. 5 arcs and 2,300 16-C.P. incandescents for private lighting. Revenue per 8 C.P. average for past 2 years 5s. 10d. Capacity of station, 3,300 16-C.P. 5d. per unit; gas 3s. 6d. per 1,000 feet. Works not yet completed. Consulting Engineer, Dr. John Hopkinson, 5, Victoria Street.

WINDERMERE.—Company. H.T. alternating. Steam and water power, Galloway boiler, Gilkes turbines, Mordey alternators. Public and private lighting Manager, F. Fowkes.

WOKING.—Woking Electric Supply Company, Limited. Alternate current transformer sub-stations. Area of district, square miles, 14 Rubber covered cables in porcelain pipes. 4 smoke-tube and 2 water-tube boilers. Engines: 1 Parsons steam turbine (75 unit), direct; 2 Corliss valve compound engines driving 2 37-unit, Mordey alternators; 1 Corliss valve triple engine, driving 1 30-unit Mordey alternator. Aggregate kilowatts, 186. 8-C.P. lamps connected, 5,500. Plant capacity, 7,000. Price, 8d. per unit; gas, 4s. 6d. per 1,000. Frequency, 100. Shallenberger meters. Hand stoking. Engineer and Works Manager A. J. Wheatley.

WOOLWICH.—Woolwich District Electric Light Company, Limited. H.T. alternating transformer system. Chandler high-speed engines, 250-H.P. Underground mains in cast-iron pipes. 3,150 35-watt incandescent lamps and 13 arcs used for private lighting. Average revenue per 8 C.P. lamp for 1895, 9s. 10d.; works' cost, 1895, 3·6d. per unit. Capacity of station, 5,000 lamps. Price per unit, 6d., gas 2s. 3d. Cost of station £11,500 approx. Engineer, G. E. B. Pritchett, 31, Soho Square, W.

WOLVERHAMPTON.—Corporation. H.T., direct (2,000 volts), with motor transformers. 3 Lancashire boilers, 3 250-I.H.P. Marshall horizontal compound condensing, one of 125 by same makers; dynamos by Electric Construction Corporation and Thomas Parker, Limited. Underground mains; armoured cables for distribution, armoured concentrics for arc lamps, and Callender solid for H.T. feeders. 51 arc lamps for street lighting, 56 arcs and 8,000 8-C.P. lamps for private lighting. Capacity generating plant 16,000 8-C.P. Price per unit, 6d.; gas, 2s. 6d. Total cost of installation £35,000, mains and services £8,000. Works' cost per unit, 1·87d.; annual revenue per 8 C.P. lamp, 7s. 1d. Borough Electrical Engineer, F. Harman Lewis, Town Hall, Wolverhampton.

WORCESTER.—Corporation. High tension alternating with transformer sub-stations. Plant capacity 500 kilowatts. 3 vertical marine type engines, each of 286 I.H.P. 2 54-in. turbines, each of 161-B.H.P. 1 48-in. of 123-B.H.P. 1 30-in. of 47-B.H.P., all at 10 feet head. 4 Babcock and Wilcox boilers, of 125-H.P. each. Brook's oil mains from works to city (2 miles). Concentric paper insulated cables for high tension, bituminised fibre insulated concentric cables for low tension. 27 arc lamps (public), 17 arcs and 12,266 32-watt incandescent lamps for private lighting. Motors equivalent to 1,706 32-watt lamps. Units delivered during 1895, 246,912. Works' cost, 2·5 pence per unit. Average price obtained, 2·7d. Price charged, 5d. per unit, less discounts, private lighting. 3d. to 1d. for power; gas, 3s. 7d., less discount. Capital expended December, 1895, £52,226.

YARMOUTH (GREAT).—Corporation. High pressure alternating current. Babcock boilers, 400-H.P., and Willans engines, armoured cables. 66 arcs for lighting streets and Fish Wharf. Capacity of station in 8-C.P., 7,250. About 150 private customers connected, equal to 6,500 8-C.P. lamps. 6d. per unit; gas, 3s. 2d. and 4s. 6d. Cost of constructing and equipping central station, £16,500. Capital expended to date, £20,000. Engineer, A. W. Ranken.